Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Computers and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Intelligent Systems and Artificial Vision

2. Date despre disciplină

2.1 Course name (ro) (en)				Computer Vision III Computer Vision III			
2.2 Course Lecturer				S.l./Lect. Dr. Mihai Dogariu			
2.3 Instructor for practical activities				S.l./Lect. Dr. Mihai Dogariu			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.03.O.16-15		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	4	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	28
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					49
Tutoring					0
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	69.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Computer Vision I, Computer Vision II
4.2 Results of learning	Basic knowledge of Python language

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Video projection system for physical presence and access to the Microsoft Teams platform for online teaching. Attendance at the course is mandatory, according to ETTI regulations.
5.2 Seminary/ Laboratory/Project	Laboratory equipped with computing systems and access to the Moodle e-learning platform for physical presence and access to the Moodle e-learning platform and the Microsoft Teams platform for online teaching. Laboratory attendance is mandatory, according to ETTI regulations.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

Course: mastering the mechanisms of designing neural network models with applications in computer vision: data pre-processing, composing the network architecture, establishing training, optimization and evaluation strategies. Study of the basic principles used in the composition of algorithms as an essential stage in the efficient development of software applications. Criteria for efficient program design. Case studies and methods for evaluating algorithm performance.

Laboratory: practical mastering, through the implementation of software programs, of the concepts taught in the course. Implementation of practical systems with real-life applications.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	- Application of fundamental and specialized knowledge developed within this master's direction to identify and develop strategies for solving complex technical problems, specific to the field of Intelligent Systems and Artificial Vision. - Ability to model and design software/hardware systems for image processing and analysis for specific applications; ability to both use existing programs (software) for image processing, and to design and implement new systems, using specific interfaces and languages. - Ability to model and design systems based on techniques in the field of artificial vision to solve typical tasks in biometrics, remote sensing, vehicular robotics, video surveillance. - Identification of the need for continuous training and the efficient use of information sources and communication resources and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) both in Romanian and in an international language.
Transversal (General) Competences	- The ability to make decisions in order to solve current or unpredictable problems that arise in the process of operating computer systems. - The ability to constantly inform and document oneself for personal and professional development by reading specialized literature. - The ability to communicate and present technical content in both Romanian and English.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* - mastering the fundamental concepts of neural networks, - mastering programming in the Python programming language and the PyTorch framework, - mastering the knowledge to design a neural network to solve a basic computer vision problem, - mastering the knowledge to track the impact on the results, as a result of the punctual changes made to the implemented model and to understand the practical effect that they have.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* - the ability to understand and explain a neural network model written in Python code, - the ability to design a simple algorithm, - the ability to validate the results of a neural network model, - the ability to identify programming solutions, - the ability to communicate and argue solutions.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* - selection and analysis of appropriate bibliographic sources, - compliance with the principles of academic ethics, correctly citing the bibliographic sources used, - receptivity to new learning contexts, - demonstration of autonomy in organizing the learning situation/context or the problem situation to be solved.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of the students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct and indirect exploration of reality (experiment, demonstration, modeling), but also on action-based methods, such as exercise, practical activities and problem solving.

Lectures will be used in the teaching activity, based on Power Point presentations that will be made available to students. Each course will begin with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.

The presentations use images, diagrams and source code examples, so that the information presented is easy to understand and assimilate.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction to computer vision and deep learning, presentation of general context, exemplification of practical applications, placement of the field in the current socio-technological framework.	2
2	Fundamentals of deep learning and taxonomy in the context of computer vision. Presentation of all components of a neural network model (layers, neurons, activation functions, cost functions), training algorithms (forward propagation, back propagation, optimizers, learning rate setting strategies), training optimization strategies (batch normalization, spectral normalization, regularization) and the 5 steps necessary to develop a robust neural network: data acquisition, data pre-processing, model training, model evaluation, and model optimization.	4
3	Presentation of different neural network architectures: fully connected networks, convolutional networks, recurrent networks.	4
4	Supervised learning and specific applications: image classification, image segmentation, image recognition, automatic object detection, etc.	9
5	Unsupervised learning and specific applications: feature extraction using autoencoders, generative models (GAN, VAE), image generation, style transfer, etc.	9
	Total:	28

Bibliography:

1. Ionescu B., Computer Vision, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9501
2. Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT press.
4. Ng A., Mourri Y. B., Katanforoosh Y., curs online, https://www.coursera.org/learn/neural-networks-deep-learning

LABORATORY		
Crt. no.	**Content**	**No. hours**
1	Introduction and familiarization with Python, PyTorch and Google Colab.	2
2	Processing input and output data.	2
3	Basic applications with simple neural network models (fully connected, convolutional, recurrent networks).	6
4	Visual information classification applications (classification, segmentation).	6
5	Object detection applications in images.	4
6	Image generation and style transfer applications.	6
7	Final colloquim	2
	Total:	28

Bibliography:
1. Ionescu B., Computer Vision, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9501
2. Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT press.
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11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- knowledge of the fundamental theoretical notions of computer vision and deep learning - solving common computer vision problems using neural networks	Practical computer exam and interview. The topics cover the entire subject, creating a synthesis between theoretical study and solving computer vision problems.	50
11.5 Seminary/laboratory/project	- solving common computer vision problems using neural networks in the Colab environment and the Python language.	Practical evaluation, on the computer, at the end of the laboratory. Final colloquium.	50
11.6 Passing conditions			
• Obtaining 50% of the total score. • Obtaining 50% of the score related to the activity during the semester. • Accumulating at least 50% of the score related to the discipline (laboratory and exam).			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

- The course curriculum provides graduates with both the knowledge necessary to understand the field of computer vision and the basics of modeling neural networks using a general language such as Python. Current technological progress is driven by the revolution in the field of deep learning, so the discipline of computer vision is fundamental in training future generations of engineers and researchers in the field;

- The program thus provides graduates with skills appropriate to the needs of current qualifications and a modern, quality and competitive scientific and technical training, which will allow them to be employed quickly after graduation. This is perfectly aligned with the policy of the Politehnica University of Bucharest, both in terms of content and structure, as well as in terms of the skills and international openness offered to students. Possible employers target both the academic environment (teaching and research profile) and the industrial research and development environment such as organizations/companies of any size, from small ones created by students/master students (e.g. start-ups and spin-offs), to multinational ones.

Date Course lecturer Instructor(s) for practical activities

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25.09.2025	S.l./Lect. Dr. Mihai Dogariu	S.l./Lect. Dr. Mihai Dogariu
Date of department approval	Head of department	
Date of approval in the Faculty Council	Dean	
26.09.2025	Prof. Dr. Mihnea Udrea	