Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

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	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Applied Electronics and Informatics

2. Date despre disciplină

2.1 Course name (ro) (en)				Inteligenţă artificială in robotică			
2.2 Course Lecturer				Prof. Dr. Ovidiu GRIGORE			
2.3 Instructor for practical activities				Prof. Dr. Ovidiu GRIGORE			
2.4 Year of studies	1	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.M1.O.01-03		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3.5	Out of which: 3.2 course	1.50	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	49.00	Out of which: 3.5 course	21	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.					48
Tutoring					0
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	51.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion and passing of the following subjects/chapters: • Linear algebra • Computer Programming • Data Structures and Algorithms • Robotics
4.2 Results of learning	Gathering the following knowledge: • Specific computer programming elements • Data structures (trees, graphs) and algorithms (sorts, traversal of trees, traversal of graphs) • Elements of robot structure and functioning

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

5.1 Course	• The lectures will take place in a proper place equipped with a video projector and blackboard. • Access to the internet infrastructure and the Moodle platform.
5.2 Seminary/ Laboratory/Project	Laboratories will take place in a proper place equipped with individual computers, access to the internet and Moodle platform, suitable programing IDE (for C++, Python, Matlab)

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)*

This course is studied within the field of Electronic Engineering, Telecommunications and Information Technologies / the Electronics and Applied Informatics (EIA) specialization and aims to familiarize students with the main notions, approaches and algorithms used in the design and development of complex intelligent systems in the field of robotics.
As a specific topic, the course addresses notions in the field of autonomous robots with movement in 2D and 3D areals, as well as for motion planning of robotic arms. The presented methods and algorithms can be used for any practical situation, but the examples in the course, as well as the applications developed in the laboratory, are for the cases of robots with 2 and 3 degrees of freedom.

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 specialty knowledge to solve complex technical problems, specific to the domain of Electronics and Applied Informatics. Elaboration of engineering solutions in solving problems from the field of robot motion planning using artificial intelligence techniques. Applying knowledge from the field of data structures and algorithms and artificial intelligence to design autonomous robot motion planning solutions.

Transversal (General) Competences	Completion of professional tasks with exact identification of the objectives to be achieved, potential risk factors, available resources, economic-financial aspects, the conditions for their completion, the working stages, the working time and the related implementation deadlines. Responsible fulfillment of multidisciplinary team tasks, assuming roles on different hierarchical levels Identifying the need for continuous training and efficient use of information sources and communication resources and assisted training (Internet portals, specialized software applications, databases, on-line courses, etc.) both in Romanian and in a international language

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.* • Lists the most important milestones that indicate the development of the field. • Defines domain-specific notions. • Describes/classifies/explains concepts, algorithms, data structures used in the addressed field. • Highlights consequences and relationships.
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).* • Selects and groups relevant information in a given context. • Reasonably uses specific principles to develop autonomous systems. • Work productively in a team. • Elaboration of a scientific text. • Experimentally confirm the identified solutions. • Solving practical applications. • Adequately interpret causal relationships. • Analyze and compare algorithms (computational complexities). • Identifies solutions and develops solution/project plans. • Formulate conclusions to the experiments performed. • Argue the identified solutions/ways to solve them.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Select and analyze appropriate bibliographic sources. Respect the principles of academic ethics, correctly citing the bibliographic sources used. Demonstrates receptivity to new learning contexts. Collaborates with other colleagues and teaching staff in carrying out teaching activities. Demonstrates autonomy in the organization of the learning situation/context or problem situation to be solved. Demonstrates social responsibility through active involvement in student social life/involvement in academic community events. Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. Realizes the value of its contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). Apply principles of professional ethics/deontology in the analysis of the technological impact of the solutions proposed in the specialized field on the environment. Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialty area. Demonstrates real-life situation management skills (collaborative vs. conflict time management).

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 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 reality exploration (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.
In the teaching activity, lectures will be used, based on Power Point presentations or different videos that will be made available to the students. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.
Presentations use images and graphics so that the presented
information is easy to understand and assimilate.
This course covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a favorable climate to discovery learning.
It will be considered the practice of active listening and assertive communication skills, as well as the use of feedback mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.
Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction. Introductory notions. Applications of mobile robots. Application of artificial intelligence in robotics. General description of a vehicular mobile robot system.	3

2	Algorithms for path finding used in discrete and known 2D spaces. Algorithms based on graph traversal: depth-first search (DFS), breadth-first search (BFS), Dijkstra's algorithm. Algorithms based on heuristic functions: A*, LPA*, D*.	4
3	Algorithms for path finding in known continuous 2D spaces. Minkowski sum. Configuration space. Visibility graphs. Determining the optimal path in continuous spaces. Methods based on the continuous spaces decomposition. Area skeletonization methods. Voronoi diagram method.	4
4	Stochastic methods used in determining the optimal path in known areas. Genetic algorithms. Evolution strategies. Ant colony algorithms.	3
5	Navigation control systems of vehicular robots. Kinematics of a vehicular robot. Control system based on linear prediction theory. Fuzzy systems for navigation. Neural networks used in the control of mobile robots	3
6	Human-robot interaction. General principles. Recognition of voice commands. Voice based person identification. Gesture recognition.	4
	Total:	21

Bibliography:

1. Ov. Grigore, Inteligenta artificiala in robotica, suport de curs electronic: ai.pub.ro; Moodle: https://curs.upb.ro/2021/course/view.php?id=9297
2. Ov. Grigore, V. Velican. B. F. Florea, Inteligență computațională și recunoașterea formelor, Politehnica Press. 2013, ISBN: 978-606-515-508-4;
3. B.F. Florea, Ov. Grigore, M. Datcu, "Compact Node Counting Exploration Algorithm", UPB Scientific Bulletin, Series C: Electrical Engineering and Computer Science, Vol.79, Iss.1, 2017, pp 113-124, ISSN 2286-3540,
4. B.F. Florea, Ov. Grigore, M. Datcu, "Learning Online Spatial Exploration By Optimizing Artificial Neural Networks Assisted By A Pheromone Map", Revue Roumaine des Sciences Techniques – Électrotechnique et Énergetique, Vol. 62, Iss.2, pp. 209–214, Bucharest, 2017
5. B.F. Florea, Ov. Grigore, M. Datcu, "Multi-Agent Exploration Based on Constraints Imposed with Graph Search Algorithms", Revue Roumaine des Sciences Techniques – Électrotechnique et Énergetique, Vol. 62, Iss.1, pp. 87–92, Bucharest, 2017, ISSN: 0035-4066
6. BF. Florea, Ov. Grigore, M. Datcu, "Pheromone averaging exploration algorithm", Proc. International Conference on Advanced Robotics (ICAR 2015), July 27-31, 2015, Istanbul, Turley, pp. 617 - 622 , ISBN:978-1-4673-7509-2
7. B.F. Florea, Ov. Grigore, M. Datcu, "Ant Based Exploration Algorithms - A Brief Survey", Proc. 9th International Symposium on Advanced Topics in Electrical Engineering (ATEE), Bucharest, Romania, 2015, pp. 889-892, ISBN:978-1-4799-7514-3

LABORATORY

Crt. no.	Content	No. hours
1	Path finding in known areals using breadth first search (BFS) algorithm and A* algorithm.	4
2	Visibility graphs. Path finding algorithms in continuous spaces.	4
3	Stochastic methods used in finding the optimal path in known areals using genetic algorithms.	4
4	Linear prediction based navigation control system for vehicular mobile robots.	4

5	Design of a fuzzy system for steering control of a vehicular robot.	4
6	Voice commands recognition algorithms for remote guidance of a robot.	4
7	Final evaluation.	4
	Total:	28
Bibliography:		

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Theoretical notions evaluation	Written examination.	20%
	Solving practical problems based on the learned knowledge	Written examination	15%
	Implementation of a practical application	Homework. Oral examinarion	15%
11.5 Seminary/laboratory/project	Theoretical notions evaluation	Oral examination	10%
	Implementation of laboratory requirements	Oral examination	20%
	Homeworks.	Oral examination	20%
11.6 Passing conditions			
• Obtaining 50% of the total score. • Obtaining 50% of the score related to the semestial activity.			

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)

• Through the carried out activities, students develop skills to offer solutions to problems and to propose ideas for improving the current level in the field of Artificial Intelligence, the industrial branch of Robotics
• In the development of the course content, knowledge / aspects described by specialized literature and own published research were taken into account.
• The course has similar content to the courses held by Berkeley University in the USA (http://ai.berkeley.edu/instructors_guide.html).
• Through the carried out activities, the development of the graduate's skills to manage practical situations that he may face in real life is considered in order to increase his contribution to the improvement of the socio-economic environment.

Date	Course lecturer	Instructor(s) for practical activities
09.09.2022	Prof. Dr. Ovidiu GRIGORE	Prof. Dr. Ovidiu GRIGORE

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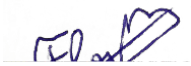
Date of department approval	Head of department
29.10.2024	Conf. Dr. Bogdan Cristian FLOREA



Date of approval in the Faculty Council	Dean
25.10.2024	Prof. Dr. Mihnea Udrea