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	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Applied Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Robotică Robotics			
2.2 Course Lecturer				Prof. Dr. Constantin Daniel OANCEA			
2.3 Instructor for practical activities				Prof. Dr. Constantin Daniel OANCEA			
2.4 Year of studies	4	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.08.O.511		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14
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.					35
Tutoring					00
Examinations					3
Other activities (if any):					20

3.7 Total hours of individual study	58.00
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/or promotion of the following subjects: • Fundamentals of Electrical Engineering 1 • Fundamentals of Electrical Engineering 2 • Signals and Systems • Industrial Electronics and Informatics • Basic Electronic Circuits • Passive Components and Circuits • Analog Integrated Circuits • Electronic Measuring Instruments • Fundamentals of Data Acquisition Systems
4.2 Results of learning	General knowledge about sensors and transducers, mechanics, drive equipment, electrical and electronic circuits, electrical signals, automation.

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

5.1 Course	The course will take place in a room equipped with video projector and computer. The presence of the Wi-Fi signal is preferable for accessing multimedia presentations
5.2 Seminary/ Laboratory/Project	• The laboratory will take place in a room with specific equipment, which must include computers (for works that contain simulations and for accessing the didactic material - files that contain the activities in the laboratory) • The following devices and equipment are required to carry out laboratory activities: robot arm (5 DOF), quadropod robot, stand for monitoring the operation of stepper motors/servomotors, autonomous robot, LiDAR equipment, etc.

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)*

The general objective of the course is to provide theoretical and applied knowledge (definitions, concepts, principles, constructive and operating elements) related to the field of robots and automata.
The discipline addresses the following basic notions, specific concepts and principles as a specific topic, all of which contribute to the transmission to students of an overview of the methodological and procedural benchmarks related to the field of robots and automata.
The specific objectives are to create the following skills and capacities:
- assimilation of specialized terms in the field of robots.
- understanding the mechanical theory (kinematics, dynamics) that is the basis of the operation of robots.
- knowledge of the principles of operation and design of robots (block diagrams, components).
- construction and operation of actuation systems (servomechanisms, motors, actuators, etc.).
- understanding the way of perceiving the environment (specific sensors)

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	Elaboration of studies, reports and documentation syntheses, respectively technical-economic related to the components of an automated system, with reference to the field of robots, demonstrating that he has basic/advanced knowledge in the field. Solving specific research-design problems in the field of robots; The ability to apply general and specialized knowledge to understand the principles of different equipment and systems used in designing and making robots; The ability to study, design, develop, implement, use, maintain and control hardware systems and IT applications specific to the operation of robots. Realization of team work in complex projects. The field of robotics, being a multidisciplinary field, correlates previously acquired knowledge. Apply methods and tools specific to the field, to carry out the design and evaluation process of a requirement and, depending on the identified/reported problems, identify solutions.
Transversal (General) Competences	1. Analysis of theoretical aspects, identification and detailing of specific components. 2. Adaptation to new technologies, professional and personal development, through continuous training using printed documentation sources, specialized programs and electronic resources in Romanian and in an international language. 3. Teamwork activities and effective communication of the student, coordinating his efforts with others to solve problems of medium complexity. 4. Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a systematic analysis process. 5. Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity.

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.* • List the most important stages that marked the development of the field of robots. • Defines specific notions, included in the field of robots (mechanics, electrotechnics, electronics, programming) • Describes coordinate transformations during robot movement. • Highlights the advantages and disadvantages of different constructive types of robots and chooses the best option for their use.

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 use of fundamental elements related to the construction and specific elements of a robot. - Understanding and using fundamental concepts in the field of robot programming, development of specific algorithms. - Solving electronic technology problems of production processes, maintenance (adjustment, testing, troubleshooting) of equipment and installations in the field of robots and development of projects of medium complexity in the specialty. - The ability to communicate and collaborate with specialists from other fields (due to the fact that robotics incorporates knowledge from different fields), different from electronics, in the sense of ensuring an interface between the technical problems encountered by them and the solutions of those problems. - The ability to function as a leader of a team that may consist of people with different specializations and skill levels. - The ability to make decisions in order to solve current or unpredictable problems that appear in the process of operating robots. - The ability to ensure the planning and management of robotics projects. - The ability to inform and document for personal and professional information by reading specialized literature. - The ability to communicate and present the operation of a robot, technically, both in Romanian and in English. - Flexibility in the use of new elements and technologies within a team where members together achieve a well-defined goal while assuming different roles or tasks.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Select appropriate bibliographic sources and analyze them. • Respect the principles of academic ethics, correctly citing the bibliographic sources used. • Demonstrates responsiveness to new learning contexts. • Demonstrates autonomy in organizing the learning situation/context or the 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 his 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 proposed solutions in the specialized field on the environment. • Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialized field. • Demonstrates real-life situation management skills (collaborative vs. conflict time management). Avoiding conflict situations and discouraging them. In the case of managerial activity, the orientation is more towards a leader's attitude, not a manager's.

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.)*

Exemplu:
The teaching is carried out through the method of expository communication and the problematization method.
Modern teaching methods (video projector) are used to present course notes, and application notes and demonstration programs are available on the computer in the laboratory.
Course notes and presentations are also available to students in electronic format (Moodle).
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 exploration and indirect of reality (experiment, demonstration, modelling), 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 or different video sequences 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 diagrams so that the information presented is easy to understand and assimilate.
This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.
Teaching is carried out through the experimentation method, using dedicated test equipment (which includes hardware and/or software components) and specialized educational software applications. Students use a simulator through which they test the created programs.
Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Terms and definitions specific to robots and automata. Classification.	2
2	Specific mechanical elements of robots. D-H representation.	4
3	Robot movement, stability. Robot dynamics.	2
4	Robot components. Architectures for robots and automata.	4
5	Drive systems (actuators, servomotors, stepper motors, pneumatic and hydraulic).	4
6	Robot senses. Specific sensors and transducers.	4
7	Programming environments specific to robots	2
8	Automations	2
9	Examples of robots (underwater robots, collaborative robots, etc.).	2
10	Final test	2
	Total:	28

Bibliography:
1. Oancea Constantin Daniel, Robotics, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9130
2. I. Eparu, D. Bădoiu, Elemente de mecanică teoretică şi de modelare a structurilor de roboţi industriali, Editura Tehnica, Bucuresti,1997.
3. T. Borangiu, A. Dumitrache, F. D. Anton, Programarea roboţilor, Editura AGIR, Bucureşti, 2010.
4. I. Bogdanov, Conducerea robotilor, Editura Orizonturi universitare, Timişoara, 2009.
5. I. Mardare, Robototehnica. Inteligenţa artificială, Editura Tehnica-Info, Chişinau, 2006.
6. I. Simionescu, I. Ion, L. Ciupitu, Mecanismele roboţilor industriali, Editura AGIR, Bucureşti, 2008.

LABORATORY

Crt. no.	Content	No. hours
1	The Open Source Simulator (GPL) with which the movements of robots can be simulated.	2
2	The V+ programming environment. Applications.	2
3	Stacks and palletizing.	2
4	Making a drawing using the simulator. Use of signaling and timing facilities.	2
5	Control of servomechanisms/M.P.P.	2
6	Programming the existing automation equipment/robots in the laboratory	2
7	Laboratory knowledge check	2
	Total:	14

Bibliography:
1. Oancea Constantin Daniel, Robotics, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9130
2. Oancea Constantin Daniel, Robotica. Note de aplicatii (disponibil tiparit)

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- knowledge and understanding of fundamental theoretical notions in the field of construction and operation of robots; - comparative analysis of different types of robot components;	Final check given at the end of the semester. The topics cover the chapters until the end of the semester.	50%
11.5 Seminary/laboratory/project	- acquiring and understanding the knowledge taught; - practical application of algorithms for simulating movements and the ability to perform complex movements. - the ability to apply theoretical concepts to solve practical problems;	Laboratory test. Monitoring of activity and involvement in laboratory work.	50%

11.6 Passing conditions
Obtaining 50% of the total score. Obtaining 50% of the score related to the activity during the semester.

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 lecture curriculum responds to the current needs and requirements for the evolution and development of manufacturing systems, offering graduates of the Applied Electronics (ELA) study program the chance to work in extremely different fields: automation and industrial equipment, the automotive industry, etc.
Graduates are provided with adequate skills with the needs of current qualifications and a modern, high-quality and competitive scientific and technical training, which will allow them to be quickly employed after graduation. This is in accordance with the requirements of the Polytechnic University of Bucharest, both from the point of view of content and structure, as well as from the point of view of the skills and international openness offered to students.
• Through the activities carried out, students develop skills to offer solutions to problems and to propose ideas to improve the situation of existence in the field of automation, the branch of industrial robots.
• Knowledge / aspects / phenomena described in specialized literature were taken into account in the development of the content of this lecture.
• Supporting a test regarding the establishment and description of the necessary operations for the creation and/or use of a robot or automated installations.

Date	Course lecturer	Instructor(s) for practical activities
22.10.2024	Prof. Dr. Constantin Daniel OANCEA	Prof. Dr. Constantin Daniel OANCEA

Date of department approval	Head of department

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

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