Syllabus

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Departament	Automation
1.4 Field of study	Systems Engineering
1.5 Cycle of study	Bachelor of Science
1.6 Program of study/Qualification	Automation and Applied Informatics (English)
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Robot Control systems***			Discipline code	47.00
2.2 Course responsible/lecturer	Conf. dr. Ing. Anastasios NATSAKIS – tassos.natsakis@aut.utcluj.ro				
2.3 Teachers in charge of applications	Conf. dr. ing. Anastasios NATSAKIS – tassos.natsakis@aut.utcluj.ro				
2.4 Year of study	4	2.5 Semester	1	2.6 Assessment *(E/C/V)*	E
2.7 Type of subject	*DF – fundamental, DS – specialty, DC – complementary*				DF
	DOB – compulsory, DOP – elective, DFA – optional				DOB

3. Estimated total time

3.1 Number of hours per week	5	of which:	Course	2	Seminar	0	Laboratory	2	Project	1
3.2 Number of hours per semester	130	of which:	course	28	Seminar	0	Laboratory	28	Project	14

3.3 Individual study	
(a) Manual, lecture material and notes, bibliography	28
(b) Supplementary study in the library, online and in the field	14
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	14
(d) Tutoring	2
(e) Exams and tests	2
(f) Other activities:	0

3.4 Total hours of individual study (sum of (3.3(a)…3.3(f)))	60
3.5 Total hours per semester (3.2+3.4)	130
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Systems Theory, Process modeling, Linear Algebra and Analytical Geometry, Python programming
4.2 Competence	Solve problems in the field of systems engineering by identifying proper methods and techniques applying mathematics and numerical calculus

5. Requirements (where appropriate)

5.1. For the course	N/A
5.2. For the applications	Presence is mandatory

6. Specific competences

Professional competences	C1 Use of knowledge of mathematics, physics, measurement techniques, technical graphics, mechanical, chemical, electrical and electronic engineering in systems engineering. C1.1 Use in professional communication of the concepts, theories and methods of fundamental sciences used in systems engineering. C1.2 Explaining the issues to be solved and arguing for solutions in systems engineering, by using techniques, concepts and principles from mathematics, physics, technical graphics, electrical and electronic engineering. C3. Use of the fundamentals of automation, of methods of modeling, simulation, identification and analysis of processes, of computer-aided design techniques. C3.1 Identifying the fundamental concepts of systems theory, automatic control engineering, of the basic principles of modeling and simulation, as well as of process analysis methods, in order to explain the basic problems in the field. C3.2 Explaining and interpreting automation problems of certain types of processes by applying the fundamentals of automation, methods of modeling, identification, simulation and analysis of processes, as well as computer-aided design techniques. C3.3 Solving certain types of management problems by: using modeling methods and principles, developing simulation scenarios, applying methods of identification and analysis of certain processes (including technological processes) and systems.
Cross competences	CT2. Identifying roles and responsibilities in a multidisciplinary team, making decisions and assigning tasks, applying networking techniques and effective work within the team. CT3. Identifying opportunities for continuous training and effectively capitalize on learning resources and techniques for one's own development.

7. Expected learning outcomes

Knowledge	The student/graduate: • Describes, identifies and summarizes concepts, methods and architectures specific to industrial and mobile robot control systems, namely: • Fundamental concepts in robotics: kinematic structures, degrees of freedom, coordinate systems, homogeneous transformations. • Geometric, kinematic and dynamic models of industrial robots. • Denavit–Hartenberg methods and the Jacobi matrix used in robot modeling. • Structures and algorithms for automatic control for industrial and mobile robots. • Principles of programming and communication for robotic systems. • Techniques for simulation, adjustment and integration of robotic systems in industrial and research applications.
Skills	The student/graduate: • Chooses and applies specific methods for modeling, driving and programming industrial and mobile robots. • Designs, implements and tests robotic applications using automatic driving algorithms and dedicated software environments. • Uses kinematic and dynamic analysis methods to solve problems specific to robotic systems. • Develops practical applications for robotic manipulation, navigation and control using specific hardware and software platforms. • Uses simulation, programming and maintenance tools for the implementation and validation of robotic systems.
Responsibilities and autonomy	The student/graduate: • Demonstrates professional responsibility and respects ethical principles in the design and use of robotic systems. • Applies safety standards and good practices in the operation of automated equipment and systems. • Works individually and in teams to develop and integrate complex robotic applications. • Demonstrates autonomy in the analysis, design and implementation of control solutions for industrial and mobile robots. • Adopts an attitude oriented towards innovation, continuous improvement and responsible use of modern robotic technologies.

8. Course objectives

General objective	Acquire knowledge in design, programming and operating industrial robots.
Specific objectives	Industrial robots modelling, Robot control algorithms, Robot programming, Industrial applications

9. Contents

9.1 Lecture	No. hours	Teaching methods	Notes
Introduction to Robotis	2	Presentation, Examples, Practical applications	
Forward kinematics – Homogeneous Transformations	2		
Forward kinematics - Denavit-Hartenberg convention	2		
Jacobian matrix	2		
Inverse kinematics	2		
Dynamic modeling	2		
Introduction to industrial robots programming	2		
Programming and Control of robots	8		
Other types of robots (mobile, drones, underwater	6		

Bibliography

1. Natsakis T – Robot Control Systems – UTPress, 2025
2. Codrean A - Introducere în modelarea și controlul roboților – UTPress, 2024.
3. Philip J.Mc.Kerrow – Introduction to Robotics – Addison-Weslwy Publ.Co.,1995.
4. John J.Craig – Introduction to Robotics (Mechanics and Control) – CRC Press 2005.
5. Lazea Gh.,E.Lupu, P.Dobra- Sisteme de conducere a robotilor si fabricatie integrata. Ed.Mediamira, 1998.
6. Mark W. Spong - Robot modeling and control – John Willey & Sons, 2004.
7. Shuai Li - Kinematic Control of Redundant Robot Arms Using Neural Networks, 2019.

9.2 Applications (laboratory)	No. hours	Teaching methods	Notes
Coordinate systems	2	Practical applications, numerical methods	
Forward kinematics	2		
Denavit-Hartenberg convention	2		
Inverse kinematics	2		
Dynamic modeling	4		
Control design for industrial robots	4		
Industrial robots programming	4		
Applications for object manipulation	2		
Applications on other robot types	4		
Evaluation	2		

Bibliography

1. Natsakis T – Robot Control Systems – UTPress, 2025
2. Philip J.Mc.Kerrow – Introduction to Robotics – Addison-Weslwy Publ.Co.,1995.
3. John J.Craig – Introduction to Robotics (Mechanics and Control) – CRC Press 2005.
4. Lazea Gh.,E.Lupu, P.Dobra- Sisteme de conducere a robotilor si fabricatie integrata. Ed.Mediamira, 1998.
5. Mark W. Spong - Robot modeling and control – John Willey & Sons, 2004
6. Peter Corke – Robotics toolbox for python

9.3 Applications (project)	No. hours	Teaching methods	Notes
Topic choice	1	Practical applications, numerical methods	
Model implementation for selected topic	8		
Interface creation and control methodology for selected topic	4		
Reporting and presentation	1		

Bibliography

1. Ramkumar Gandhinathan - ROS Robotics Projects – Packt publishing, Dec 2019

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

11. Evaluation

Activity type	11.1 Assessment criteria	1.2 Assessment methods	11.3 Weight in the final grade
Course	Demonstration of understanding of principles of robotic structures, modeling, control and applications	Written examination	60%
Laboratory	Ability to construct robotic simulations and design controller strategies	Computer examination	30%
Project	Ability to construct basic robotic simulations using ROS	Report	10%
Minimum standard of performance: Final mark (course, laboratory, and project) ≥ 5			

Date of filling in:		Title Firstname NAME	Signature
30.06.2026	Course	Conf. dr. Ing. Anastasios NATSAKIS	
	Aplications	Conf. dr. Ing. Anastasios NATSAKIS	

Date of approval by the Department Board	Head of Departament Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty Council	Dean Prof.dr.ing. Vlad MUREȘAN