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	Bachelor of Science
1.6 Program of study / Qualification	Computer Science/ Engineer
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Robot Control systems***			Subject code	**105**
2.2 Course responsible / lecturer	Lect.dr.eng. Natsakis Anastasios - tassos.natsakis@aut.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Lect.dr.eng. Natsakis Anastasios - tassos.natsakis@aut.utcluj.ro				
2.4 Year of study	3	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: *DF – fundamental, DS – speciality, DC – complementary*				DS
	Optionality: *DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice)*				DFA

3. Estimated total time

3.1 Number of hours per week	5	of which:	Course	2	Seminars		Laboratory	3	Project	
3.2 Number of hours per semester	70	of which:	Course	28	Seminars		Laboratory	42	Project	
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										25
(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										
(e) Exams and tests										2
(f) Other activities:										
3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))										55
3.5 Total hours per semester (3.2+3.4)										125
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 competence

6.1 Professional competences	C3 Operating with fundamentals of control engineering, process modelling, simulation, identification and analysis methods, and computer aided design.
6.2 Cross competences	N/A

7. Expected Learning Outcomes

Knowledge	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. • Automatic control structures and algorithms for industrial and mobile robots. • Programming and communication principles for robotic systems. • Simulation, adjustment and integration techniques of robotic systems in industrial and research applications.
Skills	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	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. Discipline objective (as results from the *key competences gained*)

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

9. Contents

9.1 Lectures	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. Philip J.Mc.Kerrow – Introduction to Robotics – Addison-Weslwy Publ.Co.,1995.

2. John J.Craig – Introduction to Robotics (Mechanics and Control) – CRC Press 2005.
3. Lazea Gh.,E.Lupu, P.Dobra- Sisteme de conducere a robotilor si fabricatie integrata. Ed.Mediamira, 1998.
4. Mark W. Spong - Robot modeling and control – John Willey & Sons, 2004.
5. Shuai Li - Kinematic Control of Redundant Robot Arms Using Neural Networks, 2019.

9.2 Applications - Seminars/Laboratory/Project	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		
Topic choice	1		
Model implementation for selected topic	8		
Interface creation and control methodology for selected topic	4		
Reporting and presentation	1		

Bibliography

1. Philip J.Mc.Kerrow – Introduction to Robotics – Addison-Weslwy Publ.Co.,1995.
2. John J.Craig – Introduction to Robotics (Mechanics and Control) – CRC Press 2005.
3. Lazea Gh.,E.Lupu, P.Dobra- Sisteme de conducere a robotilor si fabricatie integrata. Ed.Mediamira, 1998.
4. Mark W. Spong - Robot modeling and control – John Willey & Sons, 2004
5. Peter Corke – Robotics toolbox for python
6. Ramkumar Gandhinathan - ROS Robotics Projects – Packt publishing, Dec 2019

**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

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Demonstration of understanding of principles of robotic structures, modeling, control and applications	Written examination	60%
Seminar			
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:	**Responsible**	**Title First name Last name**	**Signature**
	Course	Lect.dr.eng. Anastasios NATSAKIS	
	Applications	Lect.dr.eng. Anastasios NATSAKIS	

Date of approval in the department	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council	Dean, Prof.dr.eng. Vlad Mureșan