COURSE DESCRIPTION CARD - SYLLABUS

Course name
Robotics [S1AiR1E>Rob1]

Course

Field of study
Automatic Control and Robotics

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

2,00

Coordinators

dr inż. Jarosław Warczyński
jaroslaw.warczynski@put.poznan.pl

Lecturers

Prerequisites

Knows and understands in an advanced level selected facts, objects and phenomena, as well as methods and theories explaining the complex relations between them, constituting basic general knowledge of mathematics including algebra, geometry, analysis, probabilistic and elements of discrete mathematics and logic, including mathematical methods and numerical methods necessary for: • description and analysis of linear and basic non-linear dynamic and static systems • description and analysis of complex quantities • description of control algorithms and stability analysis of dynamic systems • description, analysis and methods of signal processing in the time and frequency domain • numerical simulation of dynamic systems in the domain of continuous time and discrete time. [K1_W01 (P6S_WG)] Knows and understands in an advanced level - selected facts, objects and phenomena and their methods and theories explaining the complex relationships between them, constituting basic general knowledge in selected areas of general physics including electricity and magnetism, and solid state physics, including the knowledge necessary to understand basic physical phenomena occurring in and around automation and robotics components and systems. [K1_W02 (P6S_WG)] The graduate has an well-ordered and theoretically based knowledge of general mechanics: statics, kinematics and dynamics. The graduate knows and understands the principles of modelling and constructing simple mechanical systems. [K1_W03 (P6S_WG)]

Course objective

Assumptions and objectives of the course: Acquaintance of knowledge about robot control algorithms and about controlling robot interactions with environment.

Course-related learning outcomes

Knowledge:
Has a structured knowledge of classification, construction, kinematic structures, mathematical description, principles of operation and programming of manipulating robots; knows and understands to an advanced extent the mathematical description, properties and principles of operation and programming of simple mobile robots [K1_W15 (P6S_WG)].
Is familiar with the current status and latest development trends of the field of automation and robotics [K1_W21 (P6S_WG)].
Knows the methods, techniques, tools and materials used in solving simple engineering tasks in the field of automation and robotics [K1_W23 (P6S_WG)].
Skills:
Is able to obtain information from literature, databases and other sources also in a chosen foreign language [K1_U1 (P6S_UW)].
Can determine and use models of simple electromechanical systems and selected industrial processes, and use them for analysis and design of automation and robotics systems [K1_U11 (P6S_UW)].
Has basic operational skills regarding industrial manipulative robots; can create, test and run a simple motion programme for an industrial manipulator; can solve basic robot kinematics tasks [K1_U17 (P6S_UW)].
Is able to evaluate the suitability of routine methods and tools for designing automation and robotics systems, and select and apply the appropriate method and tools [K1_U24 (P6S_UW)].
Social competences:
The graduate is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the equipment and its components can operate. The graduate is ready to observe the rules of professional ethics and to demand it from others, to respect the diversity of opinions and cultures [K1_K5 (P6S_KR)].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Lecture: Lecture: Two variants:
Variant 1.:
• Tests will be added to each lecture on the e-kursy platform. Answers to test questions must be given before the next lecture.
• The student's final grade for the entire course will be the grade of a randomly selected student test.
• The method of grading tests is to give the student a grade of 5.0 (A) at the very beginning and then subtract 0.5 for each incorrect answer. If the result is equal to or higher than 3.0 by the end of the test, the test is assigned a grade resulting from the procedure. Otherwise, the grade will be 2.0
• Answers in the test will be considered correct if they refer to the content of the lecture and consider the context of the lecture. Often, answers generated by the AI tools are outside the context of the lecture - such answers will be graded negatively.
• Retaking requires correcting all tests, after which the grading procedure is repeated.
Variant 2. : Written test (test of theoretical knowledge) in the field of robotics

Programme content

Lecture:
In addition to discussing the importance of robotization and its prospects, the program content includes design principles for manipulators and robots and basic concepts in the field of analytical mechanics in the context of kinematic chains of robot manipulators. Other important issues include methods of determining the position and orientation of the robot tool in the task space. These issues are an introduction to the central part of the course, which are the tasks of position kinematics and velocity kinematics of the robot manipulator, necessary to understand the dynamics and control methods of robots.
Exercises:
They include an illustration of the lecture content in tasks that refer to the design issues of manipulators

and the tasks of direct and inverse kinematics of the manipulator, including planning the robot's movement trajectory in the coordinates of the task and configuration space.

Course topics

Lectures:
1. Basic concepts: kinematic pairs, kinematic chains, degrees of freedom, degree of mobility of the kinematic chain.
2. Analysis of design goals for the manipulator: design variants of the manipulator's arm and wrist, number of potential design variants of kinematic chains for non-redundant manipulators.
3. Task and configuration space: position and orientation of the manipulator tool in the task space, methods of determining tool orientation - Euler angles, axis-angle, directional cosines, quaternions
4. Homogeneous coordinates and transformations: Operations in homogeneous coordinates, uniform transformation matrix for rotation and translation, composition of transformations in homogeneous coordinates.
5. A simple kinematics problem of manipulator positions: Denavit-Hartenberg convention for describing kinematic chains and its use for combining transformations.
6. The forward kinematics of manipulator: general algorithm for solving the forward manipulator’s kinematics
7. The inverse kinematics problem of a manipulator: the issue of solvability of the inverse kinematics problem, solvability of special cases, general algorithm for the analytical solution of the inverse problem for special cases, numerical methods for solving the inverse problem.
Exercises:
They include an illustration of the lecture content in tasks that refer to the design issues of manipulators and the tasks of direct and inverse kinematics of the manipulator, including planning the robot's movement trajectory in the coordinates of the task and configuration space.

Teaching methods

1. Lecture: multimedia and board presentation,
2. Exercises: multimedia presentation, illustrated presentation,
examples given on the blackboard and the execution of the tasks given by
the lecturer - practical exercises.

Bibliography

Basic
1. Szkodny, T: Podstawy robotyki. Wydawnictwo Politechniki Śląskiej, 2012.
2. Zdanowicz: Podstawy robotyki. Wydawnictwo Politechniki Śląskiej, 2012.
3. Buratowski, T.: Podstawy robotyki. AGH Uczelniane Wydawnictwa Naukowo-Dydaktyczne, Kraków, 2006.
4. Jezierski, E.: Dynamika robotów. WNT, Warszawa, 2006.
5. Craig, J.J.: Wprowadzenie do robotyki. Mechanika i sterowanie, WNT 1993.
Additional
1. Morecki, A., Knapczyk, J.: Podstawy robotyki. Teoria i elementy manipulatorów. WNT, Warszawa, 1999.
2. Spong, M. W., M. Vidysagar: Robot modeling and Control. John Wiley & Sons, Inc., 2006
3. McKerrow, Ph. J.: Introduction to Robotics, Addison-Wesley 1991.
4. Paul, R.P: Robot Manipulators: Mathematics, Control, and Programming, Boston MIT Press 1981. (available on Internet)

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00