POZNAN UNIVERSITY OF TECHNOLOGY
EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)
pl. M. Skłodowskiej-Curie 5, 60-965 Poznań

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Robots programming and tasks planning

Course

Field of study
Automatic Control and Robotics
Area of study (specialization)
Automation and robotics systems
Level of study
Second-cycle studies
Form of study
part-time

Year/Semester
1 / 2
Profile of study
general academic
Course offered in
polish
Requirements
elective

Number of hours

Lecture
12
Laboratory classes
12
Other (e.g. online)
-
Tutorials
-
Projects/seminars
-

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
dr inż. Paweł Szulczyński

email: pawel.szulczynski@put.poznan.pl

tel. 61 6652043

Faculty of Control, Robotics and Electrical Engineering

ul.Piotrowo 3, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Knowledge: The student starting this course should have basic knowledge of the basics of robotics in the field of kinematics, dynamics regarding both manipulating robots and robots with nonholonomic constraints, including mobile robots and programming in any high-level language.

Skills: Should have the ability to solve basic problems related to the subject and the ability to obtain information from the indicated sources. They should also understand the need to expand their competences / be ready to cooperate within the team.

Social Competences: In addition, in terms of social competences, the student must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Provide students with basic knowledge of planning the trajectory of robots in Cartesian space as well as for mobile robots using elements of differential geometry. In addition, students will have knowledge of programming robots using a high-level language.

2. Developing students' skills in solving practical palletizing tasks and contour tracking with the use of various industrial robots.

3. Shaping students' teamwork skills while performing complex task planning tasks for industrial robots.

4. Provide students with the ability to maintain safety conditions in rooms where there are large robots in the presence of which tasks are performed.

Course-related learning outcomes

Knowledge

1. has advanced and deepened knowledge of methods of analysis and design of control systems; - [K2_W7]

2. has an orderly, theoretically founded knowledge of designing and analyzing optimal systems; - [K2_W8]

3. has knowledge of adaptation systems; - [K2_W9]

4. has ordered and in-depth knowledge of selected areas of robotics; - [K2_W10]

5. has ordered and deepened knowledge related to control systems and control and measurement systems; - [K2_W11]

6. has knowledge about development trends and the most important new achievements in the field of automation and robotics and related scientific disciplines - [K2_W12]

Skills

1. can make critical use of literature information, databases and other sources in Polish and in a foreign language; - [K2_U1]

2. can designate models of simple systems and processes, and use them for the purposes of analysis and design of automation and robotics systems; - [K2_U10]

3. is able to integrate and program specialized robotic systems; - [K2_U12]

4. can formulate and verify (simulation or experimentally) hypotheses related to engineering tasks and simple research problems in the field of automation and robotics; - [K2_U15]

5. is able to apply the principles of occupational health and safety appropriate for automatic and robotics positions; - [K2_U17]

Social competences

1. is aware of responsibility for their own work and is ready to submit to the principles of teamwork and responsibility for jointly performed tasks; can lead a team, set goals and define priorities leading to the implementation of the task; - [K2_K3]

2. is aware of the need for a professional approach to technical issues, scrupulous reading of the documentation and the environmental conditions in which the devices and their components may function; - [K2_K4]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) in the field of lectures:

based on answers to questions about the material discussed in previous lectures,

b) in the field of laboratories:

based on the assessment of the current progress in the implementation of tasks,

Summative assessment:

a) in the field of lectures, verification of the assumed learning outcomes is carried out by:

i. assessment of the knowledge and skills demonstrated during the problem-based written exam, which are presented during the lecture along with general remarks on how to solve them.

ii. discussion of the exam results,

b) in the field of laboratories, verification of the assumed learning outcomes is carried out by:

i. assessment of the student's preparation for individual sessions of laboratory classes and assessment of skills related to the implementation of laboratory exercises,

ii. continuous assessment during each class (oral answers); rewarding the increase in the ability to use the learned rules and methods,

iii. evaluation of the report prepared partly during the classes and partly after their completion; this assessment also includes the ability to work in a team,

Obtaining additional points for activity during classes, especially for:

i. discuss additional aspects of the issue,

ii. the effectiveness of applying the acquired knowledge while solving a given problem,

iii. the ability to cooperate as part of a team practically carrying out a detailed task in the laboratory,

iv. comments related to the improvement of teaching materials,

v. identifying students' perceptual difficulties, enabling ongoing improvement of the teaching process..

Programme content

The lecture program covers the following topics:

1. Planning the trajectory in the inner space

i. Polynomial trajectories for solving the point-to-point motion problem

ii. Linear parabolic trajectory to solve the point-to-point motion problem

2. Planning of movement in the inner space (cont.)

i. Planning a trajectory through intermediate points

ii. Linear parabolic trajectories with intermediate points

3. Planning the path and trajectory in outer space

i. Description of the trajectory in external space - Frenet's trihedral

ii. Inverse kinematics algorithms

iii. Description of the position and orientation error

iv. Linear-parabolic trajectory

4. Planning tasks in the external space

5. Discussion of energy aspects related to limitations on control in motion planning tasks for mobile robots.

Laboratory classes are conducted in the form of six 2-hour exercises in the laboratory, preceded by a 2-hour instructional session at the beginning of the semester on health and safety regulations and robot operation. Classes are carried out by 2-person (maximum 4-person) teams of students. The laboratory program covers the following four topics:

1. Planning and programming of a palletizing job for a Staubli Manipulator. The aim of the exercise is to plan and write a control program for the Staubli manipulator for a typical palletizing task. This task consists in taking elements from the feeder one by one and placing them on the pallet until it is full. Then, depalletization is performed.

2. Planning and programming of a palletizing task for the Fanuc manipulator. The aim of the exercise is to plan and write a control program for the Fanuc manipulator for a typical palletizing task using the dedicated function. This task consists in taking elements from the feeder one by one and placing them on the pallet until it is full. Then, depalletization is performed.

3. Planning and programming of a palletizing task for the KUKA Agilus manipulator. The aim of the exercise is to plan and write a control program for the KUKA Agilus manipulator for a typical palletizing task. This task consists in taking elements from the column feeder (warehouse) one by one and placing them in appropriate points on the training table. Before starting the task, calibrate the tool layout related to the gripper and the base system related to the training table. Additionally, the signaling of the task execution stage (picking up, putting away the element) should be introduced by switching on the defined digital outputs of the controller.

4. Programming the KUKA Agilus manipulator for contour tracking tasks on flat and convex surfaces. The aim of the exercise is to create a control program for the KUKA manipulator of the Agilus series for the task of tracing contours useful in the processes of glue application or welding. Tracing the selected contour can be done by a tool located in the working tip of the manipulator or by using a stationary tool, where the robot manipulates the captured element in relation to this tool.

In addition, one date is reserved for making-up and completion.

Teaching methods

1. Lecture: presentation illustrated with examples given on the blackboard, multimedia presentations

2. Laboratory exercises: conducted in the laboratory of industrial robots, students perform a series of four complex laboratory exercises, each lasting two-hour meetings, which are verified by passes and detailed reports.

Bibliography

Basic

1. Modelowanie i sterowanie robotów, K. Kozłowski, P. Dutkiewicz, W. Wróblewski, PWN, 2003

2. Metody i algorytmy planowania ruchu robotów mobilnych i manipulacyjnych, I. Dulęba, Akademicka Oficyna Wydawwnicza EXIT, 2001

3. Feedback Control of Dynamic Bipedal Robot Locomotion, E. Westervelt, J. Grizzle, C. Chevallereau, J. Choi, B. Morris, CRC Press, 2007

Additional

1. Dynamics of Multibody Systems, J. Wittenburg, Springer, 2008

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4
Classes requiring direct contact with the teacher	28	1,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)[1]	72	2,5

[1] delete or add other activities as appropriate