COURSE DESCRIPTION CARD - SYLLABUS

Course name
Automatic control and robotics

Course

Field of study
Mathematics in technology

Year/Semester
3 / 5

Area of study (specialization)

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
15

Other (e.g. online)

Tutorials
15

Projects/seminars

Number of credit points

5

Lecturers

Responsible for the course/lecturer:
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Faculty of Control, Robotics and Electrical Engineering

Piotrowo 3A, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

In the field of mathematics: algebra and differential equations.

In the field of selected branches of general physics; knowledge necessary to understand the basic physical phenomena occurring in the elements and systems of automation and robotics.

In the field of analog and digital electronic circuits; knowledge necessary to understand analog models of basic dynamic objects and to understand the operation of automatic control systems.

Is able to use basic mathematical tools and methods, including numerical ones for solving engineering problems.

Course objective

To get to know the principles and methods of analysis and design of automatic control systems. Familiarization with elements and devices used in industrial automation systems. To gain general insight into the issues of robotics. To understand the basis of robots modelling, control and programming.

Course-related learning outcomes

Knowledge

Has systematized knowledge of terminology in mathematics and selected issues in the field of engineering and technical sciences related to the field of study.

Has systematized and theoretically founded knowledge in the field of technical sciences, including electrical engineering and electronics.

Skills

Is able to construct an algorithm for solving a simple engineering task as well as implement and test it in a selected programming environment.

Is able to select appropriate sources of knowledge and obtain the necessary information from them as well as make a critical analysis and assessment of solutions to complex and unusual engineering problems.

Is able to use industrial robots, in accordance with general requirements and technical documentation; knows how to apply the principles of health and safety at work.

Social competences

Is aware of the level of their knowledge in relation to research in exact and natural sciences as well as engineering and technical sciences.

Is aware of the deepening and expansion of knowledge to solve newly created technical problems.

Is aware of their social role as a graduate of a technical university.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Evaluation of student's knowledge and skills on a written exam.

Classes: Credit based on active participation in classes and by passing the colloquium.

Laboratory: Ratings for the written tests at the beginning selected exercises. Evaluation of student's knowledge and skills based on his performance during the lab exercises and evaluation of student's reports from the performed exercises.

Students always receive a list of topics to master.

Programme content

Automation: Basic concepts, types and examples of automatic control systems. Laplace transform. Modelling dynamic objects Solving differential equations using Laplace transform. Static and dynamic linearization. Conversion of block diagrams and determination of the resultant transfer function. The characteristics in the time-domain and frequency-domain of dynamic objects and control systems: impulse response and step response, transfer function and spectral transfer function, Nyquist plots, Bode plots (magnitude and phase plot). The characteristics and properties of the basic dynamical elements. Types of controllers and their properties. Control quality indicators. Conditions and criteria for stability of linear control systems. Elements and devices of automation. Construction and basics of programming industrial controllers. Automatic control of the combustion engine.

Robotics: Basic concepts and issues: robot, robotics, manipulator, kinematic chains, degrees of freedom, internal and external coordinates. Denavit-Hartenberg notation, homogeneous coordinates and transformations. Reference systems used in a robotic nest. The basic kinematic structures of manipulators. Forward and inverse kinematics, Jacobian. Issues concerning mobile robots and their sensing and navigation. Computer vision systems.

Tutorials: Conversion of block diagrams, Laplace transform, characteristics in time-domain and frequency-domain, graphical and analytical stability criteria, object modelling in state space, stability, controllability, observability, model transformations transfer function <-> state space model, determining models and checking their properties, design of combinational switching systems, modelling robot kinematics, solving simple and inverse kinematics problems.

Laboratory: Basics of industrial robot operation, simulation of automatic control systems (Simulink).

Teaching methods

Lecture: Multimedia presentation illustrated with examples given on the blackboard.

Exercises: The tutor presents the examples using a projector or on the blackboard, then the students solve the problems on the blackboard.

Laboratory: In the laboratory of manipulating robots - learning how to program robots;
in the computer laboratory (Simulink) - simulation and testing of the properties of automatic control systems in accordance with the topics covered in the lecture and exercises.

Bibliography

Basic

1. Rumatowski Karol, Podstawy automatyki. Układy liniowe o działaniu ciągłym. WPP, 2004

2. Horla Dariusz, Podstawy automatyki - ćwiczenia rachunkowe, WPP

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4. Markowski Andrzej, Automatyka w pytaniach i odpowiedziach, WNT, 1985

5. Spong M. W. Vidysagar M. Dynamika i sterowanie robotów WNT Warszawa 1997

6. Craig.J.J. Wprowadzenie do robotyki. Mechanika i sterowanie, WNT 1993

Additional

1. Mazurek Jerzy, Podstawy automatyki, Wyd. Politechniki Warszawskiej

2. Żelazny Marek, Podstawy automatyki, PWN, Warszawa 1976

3. Brzózka Jerzy, Regulatory cyfrowe w automatyce, wyd. Mikom, Warszawa 2002

4. Findeisen Władysław, Poradnik inżyniera - automatyka

5. Bobrowski Dobiesław, Ratajczak Zbigniew, Przekształcenie Laplace'a i jego zastosowania, WPP

6. Mutambara A.: Design and analysis of automatic control, London, New York, 1999

7. Paraskevopoulos P.N.:Modern control enginneering, Marcel Dekker Inc., New York, Basel, 2002

8. McKerrow Ph. J. Introduction to Robotics, Addison-Wesley 1991

9. Fu K.S., Gonzalez R.C., Lee C.S.G. Robotics: Control, Sensing, Vision, and Intelligence, McGraw-Hill Book Comp.1989

10. Paul R.P. Robot Manipulators: Mathematics, Control, and Programming, Boston MIT Press 1981

11. Gerth Wilfried, Heimann Bodo, Popp Karl, Mechatronika - komponenty, metody, przykłady, PWN, Warszawa, 2001

Breakdown of average student's workload

	Hours	ECTS
Total workload	140	5,0
Classes requiring direct contact with the teacher	60	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam) [1]	80	3,0

[1] delete or add other activities as appropriate