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
Automatics and Robotics

Course

Field of study
Technical Physics

Year/Semester
2/4

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
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	15	
Tutorials	Projects/seminars	

Number of credit points

3

Lecturers

Responsible for the course/lecturer:
dr inż. Jarosław Warczyński

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Faculty of Control, Robotics and Electrical Engineering

Piotrowo street 3A, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Knowledge of physics, mathematics and computer science (core curriculum for second year students): basic knowledge of mathematical analysis, matrix calculus, theory of mechanisms and computer science. The ability to describe problems in physics using differential equations, based on the acquired knowledge, the ability to obtain information from the indicated sources. Understanding the need to expand your competences, readiness to cooperate as part of the team.

Course objective

1. To acquaint students with the theoretical foundations and principles of operation of automatic

control systems and robotic systems within the scope defined by the curriculum content appropriate for the field of study.

2. Developing the ability of students to solve problems in the field of control and to perform simple experiments and to analyze the results based on the acquired knowledge.

3. Shaping students' teamwork skills.

Course-related learning outcomes

Knowledge

As a result of the conducted classes, the student will have knowledge in the following areas:

1. Can choose the type of mathematical model (dynamic, static; linear, non-linear; stationary, non-stationary; continuous, discrete; deterministic, stochastic) appropriate to solve the control task [K1_W01]

2. Can use 3 methodologies for the description of dynamical systems: differential equations, state equations, operator transmittance [K1_W01]

3. Can apply frequency analysis to dynamical systems, knows the types of frequency characteristics and can use them in the analysis of control systems [K1_W01]

4. Has detailed knowledge of selected automation and robotics departments, allowing for understanding of the control process in selected, complex control and measurement systems and robotic manufacturing systems [K1_W06]

5. Knows the basic algorithms and structures of automatic control, in particular robot control. [K1_W06]

Skills

As a result of the course, the student will acquire the following skills:

1. Can apply mathematical knowledge to describe and create dynamic models of processes and structures of control systems, algorithmization of selected tasks of controlling dynamic objects. [K1_U01]

2. Can formulate mathematical models of any linear dynamical systems and selected nonlinear systems [K1_U01]

3. Is able to carry out numerical modeling and simulations of basic physical objects and their control processes with the use of standard software [K1_U19]

4. Is able to identify a complex control problem, as well as propose a diagram of its analysis and / or solution, detailing its various technical aspects, and determining the degree of complexity and assessing its feasibility [K1_U14]

5. Can use the acquired knowledge to describe processes, create models, write control algorithms; can use analytical methods to formulate and solve tasks in the field of control and analysis of control objects [K1_U01]

6. Is able to develop programs controlling dynamic objects with the use of standard devices and software [K1_U16]

Social competences

As a result of the conducted classes, the student will acquire the following social competences:

1. Can actively engage in solving given problems, independently develop and expand their competences [K1_K01].

2. Can cooperate within a team, fulfill the duties entrusted as part of the division of labor in a team, demonstrate responsibility for own work and co-responsibility for the results of the team's work [K1_K01].

3. is able to properly define the priorities for the implementation of the task set by himself or others; is aware of the importance of behavior in a professional manner; knows the risks related to the consequences of errors in the operation of automatic control systems, eg loss of stability by the system [K1_K07].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

learning outcome (symbol) form of evaluation evaluation criteria

W01	written test	3 50.1% -70.0%
		4 70.1% -90.0%
		5 from 90.1%
W02	written credit	3 50.1% -70.0%
		4 70.1% -90.0%
		5 from 90.1%
W03	written credit	3 50.1% -70.0%
		4 70.1% -90.0%
		5 from 90.1%
W04	written test	3 50.1% -70.0%
		4 70.1% -90.0%
		5 from 90.1%

W05	written test	3 50.1% -70.0%
		4 70.1% -90.0%
		5 from 90.1%
U01	Colloquium	3 50.1% -70.0%
		4 70.1% -90.0%
		5 from 90.1%
U02	Colloquium	3 50.1% -70.0%
		4 70.1% -90.0%
		5 from 90.1%

U03 exercise report

3 the student is able to use the software

laboratory, basic tools, which enablesoral and written answers him to create simple models of physical objects andsimulating them

4 the student is able to use the software fluentlytools, is able to create various models physical objects and simulate simple processes control

5 the student is fluent in operating the utility software, can create simple and complex models of objects

physical and verify their correctness, can design a control system and simulate it action

U04 exercise report

3 the student is able to apply the basic methods laboratory, object identification, knows a variety of patterns oral and written answers of control systems and their parameters

4 the student is able to apply the basic methods control objects identification and make interpretation of the obtained results. Can, on the basis of obtained results, propose a circuit diagram control.

5 the student is able to apply the basic methods identify control objects and interpret the obtained results. Can, on the basis of obtained results, propose a circuit diagram control and select its parameters. He can introduce alternative ways to control and define them advantages and disadvantages.

U05 Colloquium

3 50.1% -70.0%

4 70.1% -90.0%

5 from 90.1%

Programme content

1. Automation as a system field of knowledge - the genesis of automation development, specificity of automation as a system discipline, general, independent of the physical field, the nature of control problems, technical cybernetics. Characteristics of the subject of automation research.

2. Basic concepts - Signal, automation element, control object, disturbance, control, feedback, control device, control system, basic automatic control concepts: open loop control, closed loop control, disturbance compensation control, closed loop control with noise compensation. Classification of control systems. Static and dynamic linearization, linear dynamical systems.

3. Dynamics of control objects - Classification of control objects, methods of object dynamics description: differential equations, operator equations, operator transfer function, state equations, state space, state trajectory, time characteristics.

4. Frequency analysis - Spectral transmittance, frequency characteristics: amplitude-phase, logarithmic (Bode diagrams), logarithmic amplitude-phase characteristics.

5. Basic linear dynamic terms - equations, transfer functions, time characteristics, frequency characteristics, examples. Static and astatic objects.

6. Block diagrams of automatic control systems - Construction, substitute transfer functions of basic connections, conversion of diagrams.

7. Stability of systems - Second Lyapunov method of stability studies, necessary and sufficient condition of asymptotic stability of a linear system, stability criteria of linear systems: Hurwitz criterion, Nyquist criterion, logarithmic Nyquist criterion. Module and phase stability reserve.

8. Quality of control and regulation.

9. Linear regulators - The laws of regulation: P, PI, PD, PID. Regulators: P, PI, PD, PD-real, PID, PID-real. Selection and settings of regulators, Nichols card, Ziegler Nichols method of selecting regulator settings.

10. Discrete systems - Discrete function, difference equations, Z transform, solving difference equations, discrete transfer function, discrete time and frequency characteristics, Shannon sampling theorem, strobe phenomenon.

11. Linear digital control systems - A / C and C / A converters and their description: ideal pulser, zero-order extrapolator, digital control algorithms, digital controllers, PLC controllers.

12. Basic kinematic structures of manipulators. Denavit-Hartenberg notation. Workspace coordinates, orientation, configuration coordinates, coordinates and homogeneous transformations.

13. Simple and inverse manipulator kinematics: for position, velocity and acceleration, Jacobian. Model of manipulator dynamics. Elements of trajectory planning and robot programming

14. Robot control systems: Independent control of nodes. Point control. Continuous control. Inverse dynamics control, control with dynamic interaction compensation.

Teaching methods

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

2. Laboratory exercises: practical exercises, conducting experiments, taking measurements, discussion, team work.

Bibliography

Basic

1. Bubnicki Z.: Teoria i algorytmy sterowania. WNT, Warszawa, 2002J.J. Craig – Wprowadzenie do robotyki. Mechanika i sterowanie, WNT 1993

2. Czemplik A.: Modele dynamiki układów fizycznych dla inżynierów. Zasady i przykłady konstrukcji modeli dynamicznych obiektów automatyki. WNT, Warszawa, 2008.

3. Honczarenko, J.: Roboty przemysłowe: Budowa i zastosowanie. WNT, Warszawa, 2010.

4. Jezierski, E.: Dynamika robotów. WNT, Warszawa, 2006.

5. Rumatowski K.: Podstawy Automatyki. Część 1. Układy liniowe o działaniu ciągłym. WPP, Poznań, 2004.

6. Rumatowski K.: Podstawy regulacji automatycznej. WPP, Poznań,2008.

7. Zdanowicz, R.: Podstawy robotyki. Wyd. Polit. Śląskiej. Gliwice, 2010.

Additional

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

2. Kaczorek T., A. Dzieliński, W. Dąbrowski, R. Łopatka: Podstawy teorii sterowania. WNT, Warszawa, 2006.

3. McKerrow, Ph. J.: Introduction to Robotics, Addison-Wesley 1991Morecki, A., Knapczyk, J.: Podstawyrobotyki. Teoria i elementy manipulatorów. WNT, Warszawa, 1999.

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

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

6. Zieliński T. P.: Cyfrowe przetwarzanie sygnałów: od teorii do zastosowań. WydawnictwaKomunikacjiiŁączności, Warszawa 2005.

Breakdown of average student's workload

	Hours	ECTS
Total workload	93	3,0
Classes requiring direct contact with the teacher	51	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	45	2,0

[1] delete or add other activities as appropriate