COURSE DESCRIPTION CARD - SYLLABUS

Course name

Control basics

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 studies

Course offered in

English

Form of study

full-time

Requirements

compulsory

Number of hours

Lecture

30

Laboratory classes

30

Other (e.g. online)

Tutorials

15

Projects/seminars

Number of credit points

5

Lecturers

Responsible for the course/lecturer:

Dariusz Horla, Ph.D., D.Sc., associate professor

Responsible for the course/lecturer:

Prerequisites

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 thermodynamics, electricity and magnetism, optics, photonics and acoustics, and solid state physics, including the knowledge necessary to understand basic physical phenomena occurring in and around automation and robotics components and systems. The graduatee knows and understands in advanced level the methods of signal processing in the time and frequency domain. The graduate has an orderly knowledge of signal and information theory

[K1_W02 (P6S_WG), K1_W05 (P6S_WG)] Is able to obtain information from bibliography, databases and other sources; has the ability to self-educate in order to improve and update professional competences.

[K1_U01 (P6S_UU)] The graduatee is aware of the importance and understands the non-technical aspects and effects of engineering activities, including its impact on the environment and the associated responsibility for decisions taken. The graduate is ready to take care of the achievements and traditions of the profession

[K1_K02 (P6S_KR)]

Course objective

The lecture aims at presenting to students selected methods of analysis of control systems, basics of nonlinear control and discrete-time/digital control system. Synthesis methods of classical controllers in continuous- and discrete-time systems are also discussed.

Course-related learning outcomes

Knowledge

1. 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 random processes and uncertain quantities * description and analysis of combination and sequence logical systems * 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)]

2. Knows and understands to an advanced level the theory and methods of structures and operating principles of analogue and discrete control systems (open and feedback systems) as well as linear and simple, non-linear analog and digital controllers. [K1_W16 (P6S_WG)]

Skills

1. Is able to check the stability of linear and selected non-linear objects and dynamic systems. [K1_U07 (P6S_UW)]

2. The graduatee can use selected tools for rapid prototyping of automation and robotics systems [K1_U12 (P6S_UW)]

3. Can plan, prepare and simulate the operation of simple automation and robotics systems [K1_U21 (P6S_UO)]

Social competences

The graduatee is ready to critically evaluate his or her knowledge. The graduate understands the need for and knows the possibilities of continuous learning - improving professional, personal and social competences, the graduate is able to inspire and organize the learning process of others. [K1_K01 (P6S_KK)]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: written exam.

Exercises: verifying the ability to analytically solve control problems; periodic tests performer to assess the learning process, assessment of students' abilities when solving the problems by the blackboard.

Laboratory exercises: verification of practical abilities and knowledge from control field using simulation tools and selected problems, as well as evaluation of written reports and tests.

Pass rate at 60% of maximum number of points (exercises and laboratory exercises), and 50% (exam).

Programme content

LECTURE

Introduction to nonlinear systems. Phase-plane methods. Isoclines method. Describing function method. Analysis of nonlinear systems using describing functions. Two- and three-position control. Fuzzy control. Anti-windup compensators. Introduction to discrete-time systems. Laurent transform. Inverse Laurent transform. Sampler and extrapolator. Reconstruction of signals from samples. Design of digital control systems using conventional methods. Transient and steady-state response analysis. Analytical stability tests. Compensation in discrete-time systems. State-space description of discrete-time systems. Discretization methods. Discrete-time transfer function of the PID controller. Nyquist criterion applied to discrete-time systems.

EXERCISES

Describing function method and using it to stability analysis of nonlinear systems. Laurent transform. Inverse Laurent transform. Discrete-time models of linear systems. Stability criteria. State-spece description.

LABORATORY EXERCISES

Time response analysis of linear systems, Frequency response analysis of linear systems, Stability of linear systems, Linear controllers, Servo system, Cascade control, Tracking system, On-off control, Three-position control, Dynamics of sampled-data systems, Fuzzy control, Kessler methods, Tuning of discrete-time controllers, Anti-windup compensators

2020 UPDATE: examples

Teaching methods

Teaching methods:

a) lecture

- pdf slides (figures, photos), with additional information written on the blackboard,

- lectures accompanied by self-studying handouts via Moodle,

- theory presented with reference to current knowledge of students,

- new subjects preceded by recalling subjects connected or known from other lectures.

b) exercises

- sample problems solved on the blackboard,

- commented solutions of the solved problems by the tutor and discussing solutions.

c) laboratory exercises

- slideshows presented during laboratory exercises,

- detailed evaluation and review of reports, discussing the comments and remarks,

- demonstrating ideas using laboratory stands,

- teamwork.

Bibliography

Basic

1. Horla D., Control Basics. Exercises. Part 1, Poznań, Wydawnictwo Politechniki Poznańskiej 2016

2. Horla D., Control Basics. Exercises. Part 2, Poznań, Wydawnictwo Politechniki Poznańskiej 2017

3. Horla D., Control Basics. Laboratory exercises. Poznań, Wydawnictwo Politechniki Poznańskiej 2016

Additional

1. Franklin F.G., Powell J.D., Emami-Naeini A., Feedback Control of Dynamic Systems, 4th ed, New Jersey, Prentice Hall 2002.

2. Giernacki W., Horla D., Sadalla T., Mathematical Models Database (MMD ver. 1.0) Non-commercial proposal for researchers, 21st International Conference on Methods and Models in Automation & Robotics (MMAR 2016): IEEE, 2016, s. 555-558

3. Ogata K., Discrete-time Control Systems, 2nd ed, Prentice Hall International 1995.

4. Ogata K., Modern Control Engineering, 4th ed, Prentice Hall 2002.

5. Ryniecki A., Wawrzyniak J., Gawałek J., Horla D., Drying Control Design - Case Study on the Near-Ambient Drying of Rapeseed, Przemysł Spożywczy, vol. 71, no 4, pp. 20-23, 2017.

6. Sadalla T., Horla D., Analysis of simple anti-windup compensation in approximate pole-placement control of a second order oscillatory system with time-delay, 20th International Conference on Methods and Models in Automation and Robotics (MMAR), Miedzyzdroje, IEEE, 2015, pp. 1062-1067.

7. Shinners S.M., Modern Control System Theory and Design, 3rd ed, Nowy Jork, John Wiley & Sons, 1992.

8. Slotine J.-J.E, Li W., Applied Nonlinear Control, New Jersey, Prentice Hall 1991.

Breakdown of average student's workload

	Hours	ECTS
Total workload	150	5,0
Classes requiring direct contact with the teacher	80	3,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	70	2,0

[1] delete or add other activities as appropriate