COURSE DESCRIPTION CARD - SYLLABUS

Course name
Nonlinear control theory [S2AiR2-SW>NTS]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/1

Area of study (specialization)
Vision Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	15	0
Tutorials	Projects/seminars	
0	15	

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

A student starting the course should have basic knowledge of control theory, mathematical analysis and algebra. In addition, the student should be able to use basic information and communication technology, be able to acquire information from indicated sources, and should show readiness to cooperate within a team. They should also understand the necessity of broadening their competences.

Course objective

To provide students with knowledge of nonlinear control systems and, in particular, knowledge related to the application of mathematical analysis to the synthesis of models and control systems for selected nonlinear control objects. To teach students the basic knowledge of nonlinear systems description, their controllability, linearization and stability.

Course-related learning outcomes

Knowledge
A student:
1. has extended and deepened knowledge of selected branches of mathematics necessary to formulate and solve complex tasks in the field of control theory and modeling of complex automation systems.

[K2_W1]
2. has ordered, theoretically supported, detailed knowledge in the field of methods of analysis and design of nonlinear control systems. [K2_W7]
3. has a structured and in-depth knowledge related to control systems and control and measurement systems. [K2_W11]
4. has knowledge about development trends and the most significant new achievements in the field of automation and robotics and related scientific disciplines. [K2_W12]
Skills
A student:
1. is able to critically use information from literature, databases and other sources in Polish and foreign language. [K2_U1]
2. is able to simulate and analyze operation of complex automatic systems described by nonlinear differential equations. [K2_U9]
3. is able to determine models of complex systems and processes and use them for analysis and design of automation and robotics systems. [K2_U10]
4. is able to formulate and verify by simulation hypotheses related to engineering tasks and difficult research problems in automation and robotics. [K2_U15]
5. is able to critically analyze how control systems or robotics systems function. [K2_U19]
6. Can critically evaluate and select appropriate methods and tools to solve a task in automation and robotics; can use novel and unconventional tools in automation and robotics. [K2_U22]
Social competences
A student:
1. is aware of the responsibility for his/her own work and is ready to follow the rules of teamwork and take responsibility for tasks implemented together; is able to lead a team, set objectives and determine priorities leading to the realization of the task. [K2_K3]
2. is aware of the need for a professional approach to technical issues, scrupulous familiarization with the documentation and environmental conditions in which the equipment and its components can operate. [K2_K4]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
A) In the scope of lectures, verification of the assumed learning outcomes is realized through assessment of students' knowledge during the final written assessment in a written form.
B) In the case of laboratory classes, the verification of the established learning outcomes is realized through the current assessment of the student's progress in learning, as well as the final evaluation of the quality of the designed software, evaluation of the written report on the implementation of the tasks, as well as evaluation of the answers to the questions related to the task.

Programme content

Description of nonlinear systems in state space and tools used for their linearization. Definition of the diffeomorphic transformation of state variables and relative order for a system described by linear differential equations in state space and nonlinear systems of SISO type. Definition of the concept of distribution and involutive distribution. Definition of codistribution and its annihilator. Discussion of the Frobenius theorem on integrality of distributions. Conducting a simple computational example. Discussion of linearization by pure transformation of state variables. Discuss linearization by feedback. Define the conditions for linearization by dynamic feedback. Dynamic expansion algorithm for a nonlinear system. Definition of algebra and Lie group and a system described by a Lie group.

Course topics

Description of nonlinear systems in state space and tools used for their linearization. Definition of the diffeomorphic transformation of state variables and relative order for a system described by linear differential equations in state space and nonlinear systems of SISO type. Definition of the concept of distribution and involutive distribution. Definition of codistribution and its annihilator. Discussion of the Frobenius theorem on integrality of distributions. Conducting a simple computational example. Discussion of linearization by pure transformation of state variables. Discuss linearization by feedback. Define the conditions for linearization by dynamic feedback. Dynamic expansion algorithm for a nonlinear system.

Definition of algebra and Lie group and a system described by a Lie group.

Teaching methods

A) Lectures: multimedia presentation (slides) additionally illustrated with examples.
B) Laboratory exercises: implementation of the project tasks.

Bibliography

Basic
[1] Nonlinear Control Systems, A. Isidori, Springer-Verlag London, 1995
[2] Linearyzacja przez sprzężenie zwrotne w syntezie algorytmów regulacji dla obiektów termoenergetycznych, W.Bolek, T. Wiśniewski, Oficyna Wydawnicza Politechniki Wrocławskiej, 2006
Additional
[3] Applied Nonlinear Control, J.E. Slotine, W. Li, Prentice Hall, 1991
[4] Nonlinear Dynamical Systems, N. Nijmeijer, A.J. van der Schaft, Springer, 1990
[5] Robot Modeling and Control, M. Spong, S. Hutchinson, M. Vidyasagar, John Wiley and Sons, Inc., 2006

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50