POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Suboptimal Control of Nonlinear Systems [S2AiR2-SIiB>SSUN]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
Intelligent and Unmanned 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
30	30	0
Tutorials	**Projects/seminars**	
0	0	

Number of credit points

3,00

Coordinators

dr hab. inż. Sławomir Stępień prof. PP
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Lecturers

Prerequisites

Knowledge: Student starting this subject should have basic knowledge from linear algebra, matrix calculus, mathematical analysis and calculus, the basics of dynamic systems modeling and control theory inluding optimal control of linear systems. Skills: He should have the ability to solve basic algebra problems, mathematical analysis and geometry, control theory and the ability to obtain information from the indicated sources. Student should also understand the need to broaden its competences. Social Competence: In terms of social competence, present such attitudes as: honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Develop students' ability to analyze nonlinear systems in terms of controllability and observability 2. Providing students with basic knowledge for dynamic optimization methods without and with constraints in the context of nonlinear systems 3. Providing students with basic knowledge for parameterization of models 4. Develop ability to unerstand and develop a suboptimal control strategy for SDRE technique 5. Develop ability to understand and analyze a time-optimal and minimal energy control strategies

Course-related learning outcomes

Knowledge:
1. Knowledge related to selected problems of mathematics necessary for formulating and solving complex problems in field of nonlinear optimization theory and suboptimal control.
2. Knowledge of nonlinear dynamic systems modelling
3. Knowledge from optimization theory and design and analysis of optimization algorithms including suboptimal control.
4. Knowledge from selected optimization methods used to solve nonlinear suboptimal control problems.

Skills:
1. Critically use literature information and other sources in Polish and English
2. Build models of simple dynamic, linear and nonlinear systems
3. when formulating and solving optimization tasks, see their non-technical aspects (including environmental, economic and law aspects)
4. Appropriate methods for solving optimization problems
5. Correctly solve simple problems that have been optimized and optimally control

Social competences:
Student understands the need and knows the possibilities of continuous further education, professional, personal and social competences. He is aware of the need for a professional approach to technical problems. Understands the need and the possibility of further transfer of acquired knowledge and skills.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The summary assessment of the lectures concerns the verification of the intended learning outcomes, i.e. the assessment of the knowledge and skills demonstrated in the problem by written examination.
In the field of laboratory exercises, verification of the intended learning outcomes is carried out by continuous evaluation, in each class (oral responses, reports), in addition, by assessing the acquired knowledge and skills through one or two tests in semester.

Programme content

Lecture includes:
Modelling of nonlinear systems
Contolability and observability of nonlinear systems
Nonlinear systems parametrization, dynamic linearization.
State-Dependent Riccati Equation control technique. Finite-time and infinite-time control problem.
Neccesary and sufficient conditions. Methods of solving SDRE control problem. Closed-loop control system analysis in the context of optimal structure.
State-Dependent Riccati Equations, Algebraic Riccati Equations. Types and solving methods.
The exercises are conducted in the form of fifteen 2-hour meetings. Each meeting is prepared from a single topic. During the exercises, students solve problems related to material presented in lectures.

Course topics

none

Teaching methods

lecture: multimedia lecture with examples assisted by table explanations
laboratory classes: suboptimal problems solution and analysis, discussion

Bibliography

Basic:
1. Rumatowski K., Królikowski A., Kasiński A., Optymalizacja układów sterowania. Zadania, Warszawa, Wydawnictwa Naukowo-Techniczne 1984
2. Stadnicki J., Teoria i praktyka rozwiązywania zadań optymalizacji z przykładami zastosowań technicznych, Warszawa, Wydawnictwa Naukowo-Techniczne 2006
3. Superczyńska P., Metoda sterowania suboptymalnego z wykorzystaniem linearyzacji układu zamkniętego, Praca doktorska, Poznań 2019.

4. Donald E. Kirk, Optimal Control Theory: An Introduction, Dover Publications, 2004)

Additional:
1. Optymalizacja, Kusiak J., Danielewska-Tułecka A., Oprocha P., PWN, 2009.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	60	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	15	1,00