SYLLABUS

Name: ***Advanced dynamical system modeling (AESAu-A>SI6C-ADS24)***
Name in Polish:
Name in English: ***Advanced dynamical system modeling***

Information on course:

Course offered by department: Faculty of Automatic Control, Electronics and Computer Science
Course for department: Silesian University of Technology

Default type of course examination report:

ZAL

Language:

English

Course homepage:

https://platforma.polsl.pl/rau1/course/view.php?id=1180

Short description:

The goal of the course is to familiarise students with advanced methods of dynamical systems modelling and applying this knowledge in practice using the Matlab/Simulink package. Course participants become familiar with modelling and system analysis based on time domain approach. Participants analyse various approaches to states space models based on hydraulic or aerodynamical systems. Participants learn also how to effectively perform simulations and critically evaluate their results.

Pre-requisite qualifications include courses in Linear Algebra, Calculus, Introduction to Dynamical Systems, Control Fundamentals, Computer Programming. Students are supposed to possess basic computer programming skills.

Description:

ECTS: 2
Total workload: 60 hours (30 contact hours, 30 students' own work hours) Forms of contact hours:
Lecture 15h
Laboratory 15h

Student's own work: preparation for classes, writing reports

Lecture:
1. Introduction to dynamical systems and their categorization.
2. Lumped parameter systems and their description in time and frequency domains – a comparison.
3. State-space description of dynamical systems – stability, controllability, observability.
4. State variables – selection, transformations. System representations in modal, diagonal, aand normal regulatory forms.
5. Modelling of MIMO hydraulic and/or aerodynamical systems – derivation of state-space equations, system matrix and time solutions.
6. Regulator design for state-space models – state observers and an LQRLQG regulator design

Laboratories:
1. Matlab-Simulink interactions, variables transform, simulations settings.
2. Simulation solver selection and time-step size influence of simulation outcome.
3. Model creation based on predefined Simulink blocks, manual model composition, influence of initial conditions and comparisons with frequency-based models
4. User-defined blocks and S-function block. Matlab/Simulink simulation stages, switching between them and code tracking.
5. Level-1 and Level-2 S-functions for hydraulic and/or aerodynamical systems
6. Model composition – subsystems, ports routing, encapsulation, masking, subroutines
7. LQR regulator design

Bibliography:

1. K. Furata, A. Sano, D. Atherton: State variable methods in automatic control, Wiley, 1988
2. J.M. Maciejowski: Multivariable Feedback Design, Addison-Wesley, 1989
3. S. Skogestad, I. Postlethwaite: Multivariable Feedback Control, 1996
4. K. Zhou, J.C. Doyle, K. Glover: Robust and optimal control, Prentice Hall, 1996
5. P. P. J. van den Bosch, A. C. van der Klauw: Modeling, Identification and Simulation of Dynamical Systems, CRC Press, 1994
6. The Mathworks: Simulink 7 writing S-functions, Matlab online resources and documentation, 2007

Learning outcomes:

After completion of the course students:
Derive and use a state space description of a dynamical system - K1A_W7
Create a model of a dynamical system tailored towards a given control objective - K1A_W9
Use simulation software to create and analyse a dynamical system model - K1A_W11, K1A_U2

Assessment methods and assessment criteria:

Students need submit laboratory report(s) containing a solution to a modelling and simulation problem given by the tutor. The report is then graded according to a given table. Depending on the results, the final grade (after rounding to two digits:
[3.00 - 3.25) - 3.0
[3.25 - 3.75) - 3.5
[3.75 - 4.25) - 4.0
[4.25 - 4.75) - 4.5
[4.75 - 5.00] - 5.0
The syllabus is valid from academic year 2024/2025 and its content cannot be changed during the semester.

Course credits in various terms:

<without a specific program>

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	2	2024/2025-Z	