COURSE DESCRIPTION CARD - SYLLABUS

Course name
Adaptive control

Course

Field of study
Automatic Control and Robotics
Area of study (specialization)
Automatic Control and Robotics Systems
Level of study
Second-cycle studies
Form of study
part-time

Year/Semester
2/3
Profile of study
general academic
Course offered in
Polish
Requirements
compulsory

Number of hours

Lecture
12
Tutorials
0

Laboratory classes
12
Projects/seminars
0

Other (e.g. online)
0

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Prerequisites

A student should know fundamentals on statistics and theory of systems and control (input-output description in the continuous and discrete time domains, Laplace and Laurent transformations, Lyapunov stability analysis, linear approximation of dynamics). Moreover, he/she should have basic design skills of control systems for linear plants, skills in Matlab programming, implementation and simulation of block schemes in the Simulink environment; should have skills to acquire knowledge from selected sources, and should be ready to cooperate in a team.

Course objective

Extension of student's knowledge on designing and validation of experimental models for static and dynamic systems build based on measurement data taken from a plant; familiarization of students with selected identification techniques and methods, and shaping skills in implementation and practical utilization of identified models; presentation and explanation of selected adaptive control methods used in automatic control systems; shaping skills in practical implementation of basic adaptive control systems and shaping skills for cooperation in a small team.

Course-related learning outcomes

Knowledge

1. Deepen knowledge on selected computational techniques and mathematical methods needed for solving specialized tasks of system identification. [K2_W1]
2. Extended knowledge in the area of parametric and non-parametric (batch and recursive) identification methods for static and dynamical systems. Knowledge of basic model structures for description of dynamical systems in the continuous and discrete time domains, knowledge of basic model verification methods and knowledge of fundamental problems and their solutions in the context of preparing an identification experiment and data acquisition and processing. [K2_W5]
3. Basic theoretical and applied knowledge in the area of selected adaptive control methods ; consciousness of neccessity in applying the supervision and safety nets in adaptive control systems; knowledge of exemplary commercial systems utilizing adaptive control techniques. [K2_W9]

Skills

1. Preparation and presentation of laboratory results. [K2_U8]
2. Planning and preparation of an identification procedure in a simulation environment, and also implementation and testing of a selected adaptive control system in a simulation environment. [K2_U9]
3. Developing and validation of experimental models of single-input systems and their utilization for adaptive control purposes. [K2_U10]
4. Selection of appropriate methods and tools for solving design tasks in the areas of system identification and adaptive control. [K2_U22]

Social competences

1. Ability to cooperate in a team with a responsibility for a common task. [K2_K3]
2. Consciousness of neccessity to professionally approch to technical tasks. [K2_K4]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

A) For lectures: Verification of the teaching results in the form of a final selection test written by student s. The test includes 20 questions, every one with A,B,C,D answers, where two of them are correct and other two are false. A student earns maximally 1 point for a question if he/she selects two correct answers. One correct answer and one answer left empty results on 0.5 point. Other possibilities result in 0 points for a question. A positive mark from the test needs earning more than a half of a maximal possible number of points. The result determines the mark OT which, together with a mark OL from laboratory classes, determine (after rounding) the final mark OK computed as follows: OK = OT*0.7 + OL*0.3. The result OK < 3.0 leads to a negative mark from the course.

B) For laboratory classes: Verification of the teaching results is performed by current checks of students' knowledge (preparation to classes and verification of previously learned topics), and also by assessment of an effectiveness of students' work during classes.

Programme content

The course presentes the following topics:
- definition of a model, types and roles of models, identification as an alternative approach to modeling, pragmatic approach to empirical modeling, a general scheme of an identification procedure, modeling errors, properties of experimental models,
- structures of static models, universal structures of input-output models in the continuous and discrete time domains, linearity of the models with respect to parameters, model linearization with respect to parameters,
- predicting a response of a plant: the optimal one-step-ahead predictor vs. simulation model,
- deterministic identification methods for transfer-function models (time response approach),
- non-parametric identification by the correlation method,
- properties and general identification schemes for models in the continuous and discrete time domains,
- least squares of equation errors method (LS), weighted LS method, and statistical properties of the LS method,
- stochastic recursive least squares method, adaptive recursive identification for systems with time-varying parameters (forgetting factor),
- remarks on designing an identification experiment (SVF filtration, selection of a sampling frequency, selection and shaping excitation signals, persistency excitation order),
- identification in a closed-loop control system,
- model quality assessment methods (flexibility and parsimony of models); model validation and final model selection,
- the concept of adaptation, definition of an adaptive control system, objectives of adaptive control; properties of the ideal and practical adaptive control systems; general scheme of an adaptive control system; remarks on practical applicability of adaptive control and a decision scheme of adaptive control application,
- utilization of system identification in adaptive control; adaptive control in the MIAC (Model Identification Adaptive Control) scheme,
- selected issues on practical implementations of adaptive control systems; discussion of exemplary commercial adaptive control systems.

Laboratory classes are organized as three 4-hour meetings in a laboratory room. All students (divided into teams of 2-4 persons) perform the same set of simulation tasks:
- non-parametric identification of SISO systems (a time-response method and the correlation analysis),
- batch version of LS parametric estimation for the static and dynamical systems; recursive LS identification of a dynamical system,
- implementation, testing in simulation, and control performance assessment of an adaptive control system in the MIAC scheme with a dynamical SISO plant.

Teaching methods

A) Lectures: Presentation of slides illustrated by additional examples provided and analyzed on a blackboard.
B) Laboratory classes: Three 4-hour excercises in a laboratory room, performed by teams of 2-4 students, in a form of programming-computing and simulation tasks (Matlab-Simulink environment).

Bibliography

Basic

[1] System identification, T. Soderstrom, P. Stoica, Prentice Hall Int. 1989

[2] Adaptive control. Second edition, K. J. Astrom, B. Wittenmark, Addison Wesley, 1995

Additional

[3] Adaptive control tutorial, P. Ioannou, B. Fidan, SIAM, Philadelphia 2006

[4] Advanced PID control, K. J. Astrom, T. Hagglund, ISA, 2006

[5] Cyfrowe przetwarzanie sygnałów. Od teorii do zastosowań, T. P. Zieliński, WKŁ, Warszawa, 2007

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4
Classes requiring direct contact with the teacher	25	1
Student's own work (literature studies, preparation for laboratory classes, testing the programs after classes, preparation to a credit for classes, preparation for exam) [1]	75	3

[1] delete or add other activities as appropriate