COURSE DESCRIPTION CARD - SYLLABUS

Course name
Adaptive and robust control [N2AiR1-ISAiR>SAiO]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/1

Area of study (specialization)
Intelligent Control and Robotic Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
10

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

prof. dr hab. inż. Dariusz Horla
dariusz.horla@put.poznan.pl

mgr inż. Jacek Michalski
jacek.michalski@put.poznan.pl

Lecturers

mgr inż. Jacek Michalski
jacek.michalski@put.poznan.pl

Prerequisites

"Knows and understands in enhanced level the selected areas of mathematics. [K2_W01 (P7S_WG)] Has an advanced and enhanced knowledge of methods of analysis and design of control systems [K2_W02 (P7S_WG)] Has an organized and theoretically based detailed knowledge of the design and analysis of optimal systems. [K2_W03 (P7S_WG)] Has an organized and in-depth knowledge of modelling and identification of linear and non-linear systems. [K2_W08 (P7S_WG)]" The graduatee can construct an algorithm for solving a complex and unusual engineering task and a simple research problem, as well as implement, test and run it in a selected development environment for selected operating systems. [K2_U07 (P7S_UW)] The graduatee is ready to critically evaluate the received content. 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. [K2_K01 (P7S_KK)]

Course objective

The course aims at presenting to students basic methods and algorithms of adaptive control, as well as theory and methods of robust control. Discrete-time adaptive controllers and continuous-time robust controllers are mainly discussed.

Course-related learning outcomes

Knowledge
1. Has an organized and in-depth knowledge in the field of adaptive systems. [K2_W10 (P7S_WH)]
2. Has an organized and in-depth knowledge of modelling and identification of linear and non-linear systems. [K2_W08 (P7S_WG)]
Skills
1. The graduatee is able to use knowledge - to determine models of complex and untypical systems and processes, as well as to use them for the analysis and design of automation and robotics systems. [K2_U04 (P7S_UW)]
2. The graduatee can construct an algorithm for solving a complex and unusual measurement and computing-control task as well as implement, test and run it in a selected development environment on a microprocessor platform.. [K2_U08 (P7S_UW)]
Social competences
1. The graduatee is ready to critically evaluate the received content. 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. [K2_K01 (P7S_KK)]
2. The graduate is ready to think and act in an entrepreneurial way. [K2_K05 (P7S_KO)]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lecture: oral exam.
Laboratory exercises: verification of practical abilities, writing reports, the laboratories end with a group task (working in teams).

Programme content

LECTURES
Models of processes. Adaptive control methods. Applications of adaptive control.Model reference adaptive control. MIT and Lyapunov methods. Adaptive controllers for deterministic plants: pole-placement control, model reference control. Indirect adaptive control. Direct self-tuning controllers. Known disturbances. Gain scheduling. Minimum-variance control. Generalization of self-tuning controllers. Predictive control. Auto-tuning of PIDs.
Robust control idea. Optimal loop shaping. Optimal disturbance rejection. Robust stability. Uncertainty. Uncertainty in block diagrams. Robust stability tests. Nominal performance. Robust performance. Small-gain theorem. H_inf control problem. Design of robust controllers in Matlab.
Update 2020: examples
LABORATORY EXERCISES
Computer simulation in MATLAB/SIMULINK of basic adaptive and robus control algorithms, using recursive estimation methods. Multimedia slideshows accompanied by a discussion of solutions in selected adaptive control systems. Presentation of an adaptive control system using a laboratory stand (hardware in the loop control). Design of an adaptive and optimal control system with a full report.

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 and to practical problems,
- new subjects preceded by recalling subjects connected or known from other lectures.

b) laboratory exercises
- sample problems solved in teams,
- commented solutions of the solved problems by the tutor and discussing solutions,
- numerical experiments.

Bibliography

Basic
1. Horla D., Sterowanie adaptacyjne, Ćwiczenia laboratoryjne, 3rd ed, Wyd.Politechniki Poznańskiej, Poznań 2010
2. Królikowski A., Sterowanie adaptacyjne z ograniczeniami sygnału sterującego, Poznań, Wyd. Politechniki Poznańskiej, 2004.
3. Koziński W. , Projektowanie regulatorów: wybrane metody klasyczne i optymalizacyjne, Oficyna Wydawnicza Politechniki Warszawskiej, 2004
Additional
1. Horla D., Adaptive Predictive Controller for a Servo Drive - Actuator/Sensor Failure Study Experiments, 14th International Conference on Informatics in Control, Automation and Robotics ICINCO, Madrid, Spain , 2017, pp. 551-558
2. Horla D., C-code Implementation of an Adaptive Real-time GPC Velocity Controller for a Servo Drive, 17th International Conference on Mechatronics - Mechatronika (ME), Prague, Czech Republic, 2016, pp. 139-145
3. Horla D., Minimum Variance Adaptive Control of A Servo Drive with Unknown Structure and Parameters, Asian Journal of Control, 2013, vol. 15, no. 1, pp. 120-131
4. Horla D., Robust Performance of Sampled-Data Adaptive Control of a Servo Drive. From Simulation to Experimental Results, Journal of Automation, Mobile Robotics & Intelligent Systems, 2015, vol. 9, no. 2, pp. 3-8
5. Horla D., Simulation vs. experimental results of pole-placement controller with full adaptation, 2013 International Conference on Systems, Control and Informatics, 2013, Venice, Italy, pp. 27-33
6. Niederliński A., Mościński J., Ogonowski Z., Regulacja adaptacyjna, Warszawa WNT, 1995

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	70	3,00