(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: ADAPTIVE SYSTEMS IN CONTROL	**2. Course code**
3. Validity of course description: 2016/2017	
4. Level of studies: 2nd cycle of higher education	
5. Mode of studies: intramural studies	
6. Field of study: AUTOMATIC CONTROL AND ROBOTICS, ELECTRONICS AND TELECOMMUNICATION, INFORMATICS	RAU
7. Profile of studies: general	
8. Programme: Automatic Control	
9. Semester: 3	
10. Faculty teaching the course: Automatic Control, Electronics and Computer Science	
11. Course instructor: Jerzy Mościński, PhD	
12. Course classification: programme courses	
13. Course status: elective	
14. Language of instruction: English	
15. Pre-requisite qualifications: Course attendants are supposed to have general knowledge concerning control systems analysis and design, especially with respect to modeling and simulation of such systems. Students are also supposed to possess practical skills concerning MATLAB/SIMULINK like software usage as well as programming in language of C/C++/C#/Java kind. It is assumed that students passed the following courses: Advanced Control, System Identification, Modeling and Simulation of Industrial Systems.	
16. Course objectives: The main objective of the course is to provide the students with basic and advanced knowledge concerning theory, analysis and synthesis of adaptive control systems. During the course the students should develop the skills concerning the methods of theoretical analysis and synthesis of adaptive control systems as well as the skills of building and using computer simulation packages for analysing the behaviour of such complex control systems.	
17. Description of learning outcomes:	

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1.	Knows rules for designing and analysing adaptive control systems	assessment test	lecture	
2.	Knows rules and methods concerning tuning of control algorithms used in adaptive control systems and choosing adaptive control algorithm type according to controlled plant features and disturbances	assessment test	lecture	
3.	Knows the features and parameterization methods with respect to parameter estimation methods used in adaptive control systems and the effect of estimation method parameters choice on adaptive control properties and quality	assessment test	lecture	
4.	Can choose adaptive control algorithm according to controlled plant characteristic, disturbance properties and control objectives measured by means of specific performance index	laboratory exercise	laboratory	
5.	Can choose sampling parameters and estimation algorithm and its parameters in order to reach desired convergence properties in adaptive control system	laboratory exercise	laboratory	
6.	Can program in C/C++/C#/Java programming languages and with MATLAB/SIMULINK platforms in order to efficiently build adaptive control system model and simulation environment	laboratory exercise	laboratory	

7.	Is able to propose adaptive control system structure and tuning scheme and convince other about its usefulness	laboratory exercise	laboratory	

18. Teaching modes and hours

Lecture 30 h **/ BA /MA Seminar / Class / Project / Laboratory** 15 h

19. Syllabus description:

Lecture:

Controllers tuning task. Classification of adaptive control systems. Model reference adaptive control systems. Gain scheduling simple and advanced adaptive control schemes. Adaptive control systems with model identification. Open loop unstable and non-minimumphase plants in adaptive control. Basic plant and controller models. Demands concerning adaptive control systems stability, convergence and robustness. Direct and indirect adaptive control systems. Transfer function plant model and prediction plant model. Identification in adaptive control systems, transfer function and prediction model identification.
Stochastic disturbances as disturbance model in control systems. Deterministic disturbances: description, deterministic disturbances types, attenuating deterministic disturbances. Simulation experiments' role in analysis and synthesis of adaptive control systems. Performance assessment in adaptive control systems.
Adaptive control with pole/zero placement. Choice of poles and zeros for desired control system characteristics. Model reference adaptive control systems. Adaptive minimum variance control. Choice of control weighting scheme and parameters for minimum variance controllers. Adaptive long range predictive controllers. Predictive controllers based on parametric and nonparametric plant models, GPC control algorithm. Recursive estimation algorithms as used in adaptive control systems. Forgetting factor and its role with respect to identification methods properties. Improving numerical properties of recursive estimation methods. Stability of adaptive control systems, convergence of parameters estimates in recursive estimation algorithms.
Continuous time plant model adaptive control systems. Fuzzy logic methods for design and synthesis of control systems, fuzzy controllers design, features and application examples. Evolutionary optimisation techniques in identification and model structure choice for adaptive control systems. Multidimensional control systems with adaptation, multi input / multi output plants models, estimation techniques for multidimensional models. Autotuning, adaptive PID controllers. Adaptive filtering, filters with adaptation properties, control and telecommunications application.

Laboratory:

- Choice of structure of adaptive control systems, sampling period, measurement devices and actuators representation in simulation experiments.
- Comparison of adaptive predictive control algorithms, minimum variance control algorithms and pole/zero placement controllers.
- Choice of structure and parameters in adaptive control systems with open loop unstable and/or nonminimumphase plants.
- Numerical properties of recursive estimation algorithms in adaptive control systems.
- Synthesis of adaptive control system for nonstationary plant with typical static nonlinearities – comparison of control results for various estimation algorithms and parameters.
- Advanced MATLAB/SIMULINK based design and simulation of adaptive control systems.

20. Examination: no

21. Primary sources:

Karl Johan Åström, Björn Wittenmark, Adaptive Control, 2nd Edition, Addison-Wesley, 1995, ISBN-10: 0201558661, ISBN-13: 978-0201558661.
Rolf Isermann, Karl-Heinz Lachmann, Drago Matko, Adaptive Control Systems, Prentice Hall, 1992, ISBN-10: 0131374567, ISBN-13: 978-0131374560.
Antoni Niederliński, Jerzy Mościński, Zbigniew Ogonowski, Regulacja adaptacyjna, PWN Warszawa, 1995.

22. Secondary sources:

Petros Ioannou, Barýp Fidan, Adaptive Control Tutorial, Society for Industrial and Applied Mathematics (SIAM), 2006, ISBN-10: 0898716152, ISBN-13: 978-0898716153.
Gang Tao, Adaptive Control Systems, John Wiley & Sons, 2003, ISBN-10: 0471274526, ISBN-13: 978-0471274520.

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	30/6
2	Classes	/
3	Laboratory	15/15
4	Project	/
5	BA/ MA Seminar	/
6	Other	5/8
	Total number of hours	50/29

24. Total hours: 79

25. Number of ECTS credits: 3

26. Number of ECTS credits allocated for contact hours: 2

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 1

26. Comments:

Approved:

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(date, Instructor's signature)

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(*date , the Director of the Faculty Unit signature)*