Recomended pass through the study plan

Name of the pass: Subjects of the doctoral program Cybernetics and Robotics

Faculty/Institute/Others: Faculty of Electrical Engineering Department: Pass through the study plan: Cybernetics and Robotics Branch of study guranteed by the department: Welcome page Guarantor of the study branch: Program of study: Cybernetics and Robotics Type of study: Doctoral full-time Note on the pass:

Coding of roles of courses and groups of courses:

P - compulsory courses of the program, PO - compulsory courses of the branch, Z - compulsory courses, S - compulsory elective courses, PV - compulsory elective courses, F - elective specialized courses, V - elective courses, T - physical training courses

Coding of ways of completion of courses (KZ/Z/ZK) and coding of semesters (Z/L):

KZ - graded assesment, Z - assesment, ZK - examination, L - summer semester, Z - winter semester

Number of semes	ster: 1					
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
	P edm ty doktorského programu Kybernetika a robotika XP35FMC1,XP35CCM1, (see the list of groups below)	Min. cours.				
2020_DKYR		0	Min/Max			51/
		Max. cours.	0/0			PV
		7				

List of groups of courses of this pass with the complete content of members of individual groups

Kód		Name of the grou group (for specific	p of courses and cation see here o	codes of members of this r below the list of courses)	Com	pletion	Credi	s Scope	Semester	Role
2020_DI	KYR	P edm ty dokto	rského programi	u Kybernetika a robotika	Min. Max.	cours. 0 cours. 7	Min/M 0/0	ах		PV
XP35FMC1	Fuzzy mod	leling and control	XP35CCM1	Cooperative control of multi-age		XP35LMI1 Line		Linear matrix inequalities		
XP35NES1	Nonlinear s	systems	XP35ESF1	55ESF1 Estimation and filtering XP35ORC1 Optimal and robus		XP35ORC1		bust control		
XP35FSC1 Flexible structures control										

List of courses of this pass:

Code	ode Name of the course		Credits					
XP35CCM1	Cooperative control of multi-agent systems	ZK	4					
Cooperative distri	Cooperative distributed control is a relatively novel and rapidly developing area of control theory and engineering. Instead of centralized, large systems are considered composed of							
autonomous subsystems, with local computation and communication capabilities. The broad aim is solving classical problems e.g. stabilization, tracking, estimation and optimization,								
via local communic	via local communication and team cooperation robust to changes in communication topology and disturbance. Relevant topics of classical control theory are revisited and a brief review							
of background mathematics needed for the course is also provided. The potential use of multi-agent cooperation in challenging applications involving environment to be controlled or								
observed is discussed. Theory: Review of qualitative properties of dynamical systems, Motivation for distributed multi-agent systems, Elements of algebraic graph theory, Distributed								
estimation and control, Consensus and synchronization of linear/nonlinear, continuous/discrete-time systems, Cooperative stability, optimality and robustness, Distributed optimization:								
multi-player game theory, Interactions with environment.								
XP35ESF1	Estimation and filtering	ZK	4					
Methodology: experiment design, structure selection and parameter estimation. Bayesian approach to uncertainty description. Posterior probability density function and point estimates:								
MS, LMS, ML and MAP. Robust numerical implementation of least squares estimation for Gaussian distribution. Parameter estimation and state filtering - Bayesian approach. Kalman								
filter for white noise. Properties of Kalman filter. Kalman filter for colored/correlated noise.								

XP35FMC1	Fuzzy modeling and control	ZK	4					
In the initial lectures, the control-related fundamentals of fuzzy logic, fuzzy sets, fuzzy operations and relations are covered. Then the methodology of approximate reasoning and its								
interpretation using a basis of fuzzy rules is explained while deriving various types of inference mechanisms. Fuzzy system is interpreted as a nonlinear mapping, its properties and								
possibilities for app	possibilities for approximation are discussed. These are then exploited for modeling fuzzy systems from measured data using gradient and least-squares techniques. We then cover							
thoroughly method	Is of fuzzy clustering analysis using three most popular algorithms: fuzzy c-means, Gustafson-Kessel and Gath-Geva algorithms. We	then dedicate the	lectures to					
the analysis and sy	nthesis of Takagi-Sugeno fuzzy systems, that is, systems based on a model that was obtained either by linearizing along a trajectory	or method of sec	tions - both					
approaches are the	n compared. Careful discussion of various Lyapunov functions is included - quadratic, piecewise quadratic, fuzzy sharing the same se	egmentation of the	state space					
as the linear submo	odels. The problems are formulated as convex optimization invoking the frameworks of linear matrix inequalities (LMI) and sums of so	quares (SOS). Fina	ally, we also					
show basic design n	nethods for fuzzy adaptive regulators, both direct (backstepping, fuzzy sliding mode control) and indirect (Fuzzy Model Reference Ada	otive Control). Simi	lar methods					
	are finally applied for control using neural networks.							
XP35FSC1	Flexible structures control	ZK	4					
The main aim of the	his course is introduction to methods of modeling flexible mechanics structures in order to optimization of placement of sensors and	actuators. The robi	ust control					
	design of space modes will be follow.							
XP35LMI1	Linear matrix inequalities	ZK	4					
Semidefinite progra	amming or optimization over linear matrix inequalities (LMIs) is an extension of linear programming to the cone of positive semidefini	te matrices. LMI m	ethods are					
an important mod	lern tool in systems control and signal processing. Theory: Convex sets represented via LMIs; LMI relaxations for solution of non-con	vex polynomial op	timization					
problems; Interior-p	oint algorithms to solve LMI problems; Solvers and software; LMIs for polynomial mehods in control. Control applications: robustness a	nalysis of linear ar	nd nonlinear					
systems; design of f	fixed-order robust controllers with H-infinity specifications. For more information, see http://www.laas.fr/~henrion/courses/lmi Výslede	k studentské anke	ty p edm tu					
	je zde: http://www.fel.cvut.cz/anketa/aktualni/courses/XP35LMI							
XP35NES1	Nonlinear systems	ZK	4					
The goal of this cou	urse is to help student develop a deeper and broader perspective on theory and applications of nonlinear systems. At the hearth of the	ne course will be th	e so-called					
differential-geometric approach, which can be used for controllability and observability analysis of nonlinear systems, characterization of various types of exact feedback linearization								
and many other tasks. Great attention is paid to analysis of the structure of nonlinear systems from the perspective of control design. It follows from the state description of nonlinear								
systems and uses state transformations of the nonlinear model into a simpler form that is usable for control design. Differential-geometric conditions for existence of these transformations								
are studied in this course. Concepts of nonlinear controllability and observability are introduced in this course and their relation to stabilization and reconstruction is analyzed because								
it is not as clear as for linear systems. Some additional topics such nonsmooth stabilization and discontinuous stabilization will be covered. Examples of use of the presented theories								
	in underactuated robotic walking, nonholonomic systems and optimization of biosystems will be given.							
XP35ORC1	Optimal and robust control	ZK	4					
This is an advance	ed course about modern control design methods that formulate the design as a mathematical optimization. Besides teaching practica	I design skills, the	course will					
also help develop deeper understanding of fundamental concepts as well as build awareness of the latest results. Thanks to its background in mathematical optimization, the benefits								
of the course can certainly be seen beyond the borders of automatic control domain. The course can be viewed as an extension of the equal-named course in the master program								
(B3M35URR). However, numerous topics are new and those few topics that already appeared in the master version will be discussed at a significantly deeper level. This time the								
motivation is not just to give practical tool but also to go through the proofs, discuss various interpretations, and survey the results from the latest literature. From the student perspective,								
the goal of this course is to acquire advanced competences (knowledge and skills) in the area of computational design of control systems (or rather control algorithms). The methods								
will almost exclusively assume availability of a mathematical model of the system to be controlled (nence model-based control design), we will consider dynamical systems in continuous								
as well as discrete time, linear and nonlinear, single and multiple inputs and outputs. Since all the design methods introduced in this course formulate the design task as an optimization,								
of variations, operator theory differential earnes)								
or variations, operator theory, differential games).								
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For updated information see <u>http://bilakniha.cvut.cz/en/f3.html</u> Generated: day 2025-07-11, time 07:37.