SLOVAK UNIVERSITY OF TECHNOLOGY
FACULTY OF CHEMICAL TECHNOLOGY
DEPARTMENT OF PROCESS CONTROL
RADLINSKÉHO 9, 812 37 BRATISLAVA
SLOVAK REPUBLIC

ANNUAL REPORT

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II TEACHING AND RESEARCH LABORATORIES

II.1 Teaching Laboratories:

Laboratory of Measuring Instruments and Techniques
Laboratory of Process Control

Laboratory of Gas Analysis
Computer Laboratory (PC 386, 486, Pentium)
Computer Laboratory (UNIX)

II.2 Research Laboratories:

Laboratory of Biochemical Process Analysis and Control
Laboratory of Chemical Reactor Analysis and Control
Laboratory of Distillation Column Analysis and Control
Laboratory of Computer Aided Design
Laboratory of Modelling and Simulation

III. TEACHING

III.1 Undergraduate Study

2nd semester (spring)

Informatics	(1-2 h)	Fikar, Karšaiová, Maťko, Ondrovičová, Seč, Vasičkaninová

5th semester (autumn)

Computer Based Data Processing	(0-2 h)	Čirka, Dzivák, Jelenčiak, Karšaiová, Kožka, Lázničková, Ondrovičová, Seč, Vasičkaninová

6th semester (spring)

Automatic Control Fundamentals	(2-0 h)	Danko, Mészáros
Laboratory Exercises of Automatic Control Fundamentals	(0-2 h)	Bakošová, Danko, Dzivák, Jelenčiak, Karšaiová, Kožka, Lázničková, Maťko, Seč, Ondrovičová, Vasičkaninová, Zemanovičová
Bachelor projects		Bakošová, Danko, Dvoran, Karšaiová, Maťko, Mészáros, Ondrovičová, Seč, Vasičkaninová, Zemanovičová

7th semester (autumn)

Process Control	(1-2 h)	Mészáros
Process Dynamics	(2-0 h)	Bakošová
Operating Systems	(1-1 h)	Seč
Control Devices and Systems	(2-1 h)	Danko

Computer Programs	(1-2 h)	Rusnák
Laboratory Projects	(0-8 h)	Karšaiová, Rusnák, Seč, Vasičkaninová, Zemanovičová

8th semester (spring)

Optimisation	(2-1 h)	Dvoran
Control Theory I	(2-2 h)	Mikleš, Čirka, Kožka
Laboratory Exercises of Control Theory I	(0-2 h)	Čirka, Kožka
Experimental Identification	(2-0 h)	Fikar, Mikleš
Laboratory Project II	(0-6 h)	Dvoran, Fikar, Mészáros, Mikleš
Modelling and Control of Polymerisation Processes	(2-2 h)	Dvoran
Process Dynamics	(2-0 h)	Bakošová
Laboratory Exercises of Process Dynamics	(0-1 h)	Bakošová

9th semester (autumn)

Control Theory II	(2-0 h)	Mészáros
Laboratory Exercises of Control Theory II	(0-2 h)	Mészáros
Intelligent Control Systems	(2-0 h)	Dvoran
Semestral Project	(0-10 h)	Dvoran, Dzivák, Jelenčiak, Karšaiová, Kožka, Mészáros, Ondrovičová
CAD Systems	(2-0 h)	Karšaiová
Industrial Applications of Process Control	(2-0 h)	Mikleš
Control of Technological Processes	(1-2 h)	Bakošová

10th semester (spring)

Diploma Theses		Bakošová, Danko, Fikar, Karšaiová, Mészáros, Vasičkaninová

III.2 PhD Study

Topics in Control Theory	(2 h)	Mikleš
Intelligent Control Systems	(2 h)	Dvoran
Modelling and Simulation of Processes	(2 h)	Mészáros
Software and Hardware		

of Control Systems (2 h) Danko

III.3 Course contents

III.3.1 Lectures

Automatic control fundamentals (2h/week, 6th semester)
Basic principles of devices and methods for measurement of technological quantities. Devices for control of technological processes. Continuous-time, discrete and digital controllers. Servo-drives. Industrial controllers. Modelling of special types of processes of chemical technology. Static and dynamic behaviour of controlled systems. Closed loop for control of technological processes. Controllers. Dynamic behaviour of a closed loop. Stability of systems. Synthesis of controllers. Control of special types of processes of chemical technology.

Process Control (1h/week, 7th semester)
Introduction to process control. Mathematical models of linear and nonlinear continuous-time systems. Various forms of mathematical description of linear continuous-time systems and their connections. Input-output differential equation, transfer function, frequency-response function, state-space equation and its solution, mathematical description of systems with time delays. Responses of linear continuous-time systems: step, impulse and frequency responses, responses on arbitrary signals. Internal properties of linear continuous-time systems: stability, controllability, reachability, observability, properness, stabilisability. Feedback control loop. Basic types of controllers, quality of control, controller synthesis. Methods for controller synthesis. Mathematical models of linear discrete-time systems. Methods for discrete controller synthesis. Control of basic process units of chemical technology.

Process Dynamics (2h/week, 7th semester)
Basic approaches to process modelling. System classification according to accepted mathematical models. State-space and input-output models. Dynamic properties guessed from the models. Linearisation of nonlinear models. Nonlinear and linearised models of serially connected tanks, the static and dynamic properties. Dynamic properties of processes with heat exchange: tank heat exchangers with ideal mixing of media, tube heat exchangers, down-stream and upstream cases. Dynamic properties of processes with material exchange: plate distillation columns, stuffed distillation columns, stuffed absorption columns. Dynamic properties of processes with chemical reactions: continuous-time stirred tank reactors, tube reactors without or with catalyst.

Operating Systems (1h/week, 7th semester)

Types of computers, basic hardware of computers, basic components and their classification, periphery equipment. Introduction to operating systems of computers. Multitasking, types of multitasking and their comparison. MS Windows, its versions and their comparison from the operating system point of view, configuration of MS Windows. Linux – operation system of UNIX-type, its installation and types. UNIX operating system, its properties, structure, commands, shells, editors. WAN nets. INTERNET and SANET nets. Communication tools telnet, elm, talk, ftp, gopher, www (lynx, netscape). LAN nets, their types and comparison. NetWare 3.x, 4.x, properties and philosophy. TCP/IP protocol, its configuration. Samba server and nwserver under the UNIX-type operating systems.

Control Devices and Systems (2h/week, 7th semester)

Continuous-time controllers, types and their static and dynamic behaviour. Discrete controllers, their dynamic behaviour and using in an closed-loop. PC in the role of a controller. Servo-drives for electric and pneumatic control system. Control valves. Digital devices. Logic functions, electric devices for realisation of logic functions. Sequence loops. Hardware for control of technological processes. Analog input modules, A/D, D/A converters. Digital input modules. Sources of inaccuracies in control loops.

Computer programs (1h/week, 7th semester)

Matlab programming language: internal properties, variables, functions, data analysis, data visualisation, data storing, programming in Matlab. Simulink simulation language: simulation schemes, block parameter settings, simulation parameter setting, block libraries, s-functions. Matlab – Control toolbox: simulation and control of systems. Origin – graphic software, data processing, data visualisation, special functions. Word - text processor.

Optimisation (2h/week, 8th semester)

Static optimisation, classification of problems, goal functions, boundaries. Extremum without boundaries – analytical methods. Single-dimensional case, multi-dimensional case, Hess matrix. Conditions for extremum. Extremum with boundaries – linear boundaries, direct method, method of Lagrange multipliers. Extremum with boundaries – nonlinear boundaries, Kuhn – Tucker theorem. Non-gradient methods – Box-Wilson method, flexible simplex method, method of cyclic exchange of parameters. Gradient methods – Regula falsi method, Newton method, Broyde method, DFP method, PARTAN method. Convergence of gradient methods. Heuristic and learning methods, genetic algorithms. Linear, dynamic, nonlinear programming. Optimal and strategic decision making. Large-scale optimisation tasks and their decomposition.

Control Theory I (2h/week, 8th semester)

Continuous-time systems, discrete systems. Pole-placement method. State-space approach. Deterministic state estimate. Dynamic output feedback. Connections between state and input-output approach to control design. Pseudo-state. Asymptotic observer. Control law based on an observer for deterministic problem. Fractional approach, set of all stabilising controllers. BIBO stability. Parameterisation of stabilising controllers. Bezaut equation. Dynamic optimisation. Principle of minimum. Fundamental theorem of the variation calculus. Necessary conditions for the optimal control. LQC problem. Kalman linear (L), quadratic (Q) controller. Euler-Lagrange equations. Optimal control. Matrix Riccati equation. Output control. LQ controller with integral properties. LQ control. Connections between the state-space and input-output approaches. Spectral factorisation. LQ control and deterministic state estimation. Polynomial solution of the problem. PI controllers and LQ controller design. Optimal LQ tracking of SISO systems, input-output approach. State and parameter identification. LQ state controller, LQG input-output controller. H_2 feedback control. Solution by using of two generalised algebraic Riccati equations. Connection between LQG and H_2 control.

Experimental identification (2h/week, 8th semester)

The identification of dynamic systems from their step responses of the 1st and 2nd order, Strejc, Šalamon, Hudzovič, Söderström methods. Statistical identification methods. Classification of models for experimental identification. Least-square method, recursive least- square method, lemma about the matrix inversion, REFIL, LDFIL, LDDIF algorithms. Prediction error method and auxiliary variable method. Using of recursive identification methods for identification of multivariable and continuous-time systems. Aspects of the least square method and identification of static models, passive and active experiment. Correlation methods of identification, stochastic signals, correlation functions. Wiener-Hopf equation and its using for identification. Filtration and prediction of signals. State estimation and observability – Lueneberg observer, Kalman filtration. Using of identification for modelling and control of technological processes.

Modelling and Control of Polymerisation Processes (2h/week, 8th semester)

Principles of modelling of processes of chemical technology. Analytical and experimental approaches to modelling. Identification of static models based on the least square method. Recursive identification of discrete dynamic models. Analysis of synthesis, modification and production of polymers from the measurement and control point of view. Analysis of fibre production from the measurement and control point of view. Analysis of tire production from the measurement and control point of view. Analysis of processes of polygraphic technology from the control point of view. Analysis of processes of pulp and paper technology from the control point of view.

Control Theory II (2h/week, 9th semester)

Algebraic theory of linear control, mathematical basement. Using of algebraic theory for continuous-time and discrete controller design, pole-placement, dead beat. Adaptive control. Self-tuning adaptive systems, recursive identification. Continuous-time and discrete adaptive control. Model reference adaptive control systems (MRAS), principles, MRAS according to MIT, MRAS in the sense of Ljapunov theory of stability. Predictive control. Robust control, H_2 and H_∞ control.

Intelligent Control Systems (2h/week, 9th semester)

Expert systems – knowledge based systems. Knowledge representation. Basic features of expert systems, structure and processing. Diagnostic expert systems. Planning expert systems. Expert systems based on rules, frames and logical programming. Programming tools for expert systems – programming languages LISP and PROLOG. Fuzzy systems. Basic principles of fuzzy sets and fuzzy logic. Fuzzy decision processes, fuzzy modelling and identification. Design procedures for fuzzy logic controllers. Rule based fuzzy controllers, model based fuzzy controllers. Neural nets. Basic principles of artificial neural nets (ANS). Representation of dynamic systems using feed-forward and feedback neural nets. System identification based on using of neural nets. Parameter estimation and neural net training. Controllers based on using of neural nets. Adaptive control based on using of neural nets, direct and non-direct. Genetic control algorithms. Control of textile production.

CAD systems (2h/week, 9th semester)

Classification of automatic control systems, types of control algorithms. Automatic control system design. Feedback control loops – simple, composed. Control loops for flow rate, pressure, level control. Control loops for heat exchangers, distillation, absorption, extraction columns, batch and continuous-time chemical reactors. MIMO control of distillation columns. Large-scale systems – analysis, modelling and control.

Industrial Application of Process Control (2h/week, 9th semester)

Introduction to industrial application of process control. Problems connected with control system design and control system application in practice. Hardware and software of industrial control systems, programming of industrial automata, data processing and visualisation. Control of a chemical reactor for a decomposition of H_2O_2. Control of a binary plate distillation column. Solving of control problems for chemical industry.

Control of Technological Processes (1h/week, 9th semester)

Introduction to process control. Mathematical models of basic process units of chemical technology. Principles of control of technological processes. Methods for controller synthesis, types of control loops. Control of heat exchangers, controlled and action variables, control loops. Control of distillation and absorption columns, controlled and action variables, control loops. Control of chemical reactors, controlled and action variables, control loops.

III.3.2 Laboratory exercises

Informatics (2h/week, 2nd semester)

MS Windows 95 operating system. MS Excel as a tool for data processing, data processing by tables, data visualisation by graphs. MS Word – text processor.

Computer based data processing (2h/week, 5th semester)

Matlab – Simulink as a tool for system simulation, Matlab – Control toolbox. Filtration of signals, analog and digital filters, Matlab – Signal processing toolbox. MS Excel as a tool for data processing. Data processing by tables, data visualisation by graphs, analytical tools in MS Excel, statistics in MS Excel. Origin as a tool for data visualisation and processing.

Laboratory exercises of Automatic Control Fundamentals (2h/week, 6th semester)

Measurement of technological quantities: pressure, flow-rate, level, temperature. Measurement of static characteristics and step responses of sensors and transmitters. Measurement of dynamic properties of a pneumatic PI controller. Simulation of step responses of a heat exchanger, a tank and two serially connected tanks.

Laboratory exercises of Control Theory I (2h/week, 8th semester)

Simulation of pole-placement method. State-space approach. State observer design for simple systems. Simulation of state feed-back. Simulation of feedback control with a state observer. Design of a set of stabilising controllers for simple systems. Simulation of MIMO feedback systems by using of stabilising controllers. Simulation of feedback control by using of a LQ controller for simple serially connected tanks and for a chemical reactor. Synthesis of a PI controller, PI controller design by LQ method. Simulation comparison of a classic and a LQ PI controllers. Simulation of LQ control with deterministic state estimation. LQG state controller. Simulation of feedback control by a state-space LQG controller. LQG input-output controller. Adaptive control. Closed-loop identification. Closed-loop recursive identification. Simulation of adaptive control with recursive identification and with LQ/LQG controller. Adaptive control of serially connected tanks, adaptive control of a chemical reactor.

Laboratory exercises of Process Dynamics (1h/week, 8th semester)
Simulation of dynamic properties of systems in Matlab – Simulink. Stability conditions and responses of systems on standard input signals. Transformation of state-space description to transfer function and vice-versa, transformation of higher order differential equation to a system of the 1st order differential equations. Analysis of static and dynamic properties of a system of serially connected tanks with/without interactions. Analysis of static and dynamic properties of a tube heat exchanger as a system with continuously distributed parameters. Modelling of a system with continuously distributed parameters, transformation of a system of partial differential equations to a system of ordinary differential equations by discretisation. Calculation of a steady-state of a plate distillation column, analysis of static and dynamic properties of a plate distillation column as a system with discretely distributed parameters. Analysis of static and dynamic properties of an exothermic continuous-time stirred tank reactor. Calculation of steady-states of chemical reactors, steady-state analysis of chemical reactors, linearisation of nonlinear models.

Laboratory exercises of Control Theory II (2h/week, 9th semester)
Algebraic theory of linear control. Control of the 2nd order continuous-time system by discrete controller. Self-tuning adaptive control system for the 2nd order linear system, discrete and hybrid approach. Model reference adaptive control (MRAC). Adaptation of static gain. MRAC for the 1st and 2nd order systems. MRAC in the sense of the Ljapunov theory of stability, application on the 1st order system. Predictive control.

IV. CURRENT RESEARCH ACTIVITIES

IV.1 Research Projects

1. Advanced methods for control of processes with material exchange and processes with chemical reaction (Ján Mikleš)

Most units of chemical technology are described by non-linear models. Non-linear models and techniques and robust approach to control design are nowadays urgently developed, verified and investigated. The main goals of the project can be formulated in the following items:

a) development of methods for derivation of simplified models of processes with material exchange (distillation, absorption or extraction columns), heat exchange (heat exchangers) and systems with reactions (chemical reactors), and development of filtration methods for filtering of measured variables
b) design of multivariable intelligent and robust controllers for distillation columns, chemical reactors and other plants of chemical technology
c) investigation of control methods for systems with uncertainties, development of adaptive and robust controllers for parametric uncertainties
d) investigation of decentralised control methods and design of hierarchical control structures based on modern optimising methods
e) development of control algorithms for processes of chemical technology based on model reference adaptive control (MRAC)
f) implementation of obtained results in laboratory conditions

In the frame of this project the predictive control based on a stochastic approximation method was investigated. Further, adaptive control algorithms were also developed. The algorithms are based on using of external input-output continuous-time, discrete z and discrete delta models. Some of these algorithms are decentralised ones, which are used for control of multivariable chemical processes. A fuzzy controller for control of chemical reactors was designed. Very sufficient methods for dynamic optimisation of distillation columns were suggested. These methods are based on iterative dynamic programming or on control vector parameterisation.

2. Adaptive and Intelligent Control of Biochemical and Chemical Processes (Alojz Mészáros)

The problem of applications of modern control techniques for industrial biochemical processes is investigated. This effort is often hampered by the lack of adequate mathematical models and tools as well as the absence of on-line sensors and monitoring devices. Consequently, in comparison with traditional chemical industrial processes the fermentation and other biochemical processes still hold a backward position in respect of the application of modern control techniques.

The main goals of the project can be listed as follows:

a) development of software package based on artificial neural networks for modelling and control strategies at adaptation and organisation layers of the hierarchical control structure

b) design, testing and comparison of intelligent and robust controllers, non-adaptive and adaptive ones, for biochemical reactors and other plants of biochemical technology with final aim of their direct computer control

c) development and verification of modern integrated optimising algorithms, suitable for the optimising layer of the hierarchical multilayer control structure

d) implementation of principles of fuzzy control, neuro-fuzzy control and decentralised control to control structures for biochemical and chemical processes

e) implementation of suitable sensors and controllers on a laboratory fermenter

f) testing and verification of implemented algorithms and methods in real-time control of a laboratory fermenter

In the frame of this project, several important results were obtained. The capability of self-recurrent neural networks in dynamic modelling of continuous fermentation was investigated. Further, a constrained predictive control strategy using artificial neural networks (ANN) was designed. The recurrent ANN is used as a multi-step ahead predictor. The control action is provided by the multilayer feedforward ANN.

IV.2 Main Research Areas

1. Modelling and Simulation (M. Bakošová, M. Karšaiová, A. Mészáros, J. Mikleš, M. Ondrovičová)

Modelling and simulation play an important role in the investigation of static and dynamic properties of chemical processes, units and systems. Most chemical systems are strongly non-linear and their simulation is necessary for the control design as well as for the investigation of the overall control systems. The main aim of the research is to develop program packages for modelling and simulation of various kinds of models. During the last year a package for PC in Simulink and C-language was created.

2. System Identification (Ľ. Čirka, M. Fikar, J. Mikleš)

System identification deals with problem of the parameter estimation of static or dynamic systems from observed input-output data. Among many topics of system identification, the following areas have been investigated in this project:

a) nonparametric methods, correlation and spectral analysis
b) recursive identification of Z-transform discrete-time models
c) recursive identification of delta models which converge to their continuous-time counterparts
d) identification in closed-loop

A program package IDTOOL has been developed for Simulink. This toolbox implements recursive LS algorithm LDDIF and provides blocks for continuous and discrete time parameter estimation.

3. Optimal Control Design (M. Fikar, J. Mikleš)

The main aim of this area is to develop a package of algorithms and program implementation of various known control design for a given plant. The research interests include single input-single output systems as well as multivariable dynamic systems. Control design covers strategies in discrete-time and continuous-time formulation. A program package is created in Matlab and Simulink environment.

4. Adaptive Controllers (M. Bakošová, Ľ. Čirka, M. Fikar, A. Mészáros, J. Mikleš)

Most of technological plants exhibit non-linear behaviour. To apply a successful control design to practical problems is a substantial effort. The processes are known to be modelled and controlled with serious difficulties caused by their non-linear behaviour, high order dynamics, and tendency to instability. Many of industrial processes must be considered as multivariable systems. In a great deal of available control design techniques it is often necessary to carry out the steps of modelling, identification and control design. Theory and implementation of adaptive control in technological systems have been the long-time research topics. The activities in the adaptive control have been concentrated to three main areas as follows:

a) self-tuning control - characterised by repeating parameter estimation and control design
b) model reference adaptive control based on the Lyapunov method
c) decentralised adaptive control

5. Neural Networks and Fuzzy Control (J. Dvoran, M. Fikar, A. Mészáros, A. Vasičkaninová, A. Zemanovičová)

The aim of this research is to investigate fuzzy controllers based on genetic algorithms, two-layer hierarchical control structures for biochemical systems, integrated optimising algorithms for higher layers of hierarchical control structures, artificial neural-network models obtained by back-propagation for specified biochemical systems, design of a robust long-range constrained predictive control algorithms on the basis of ANN involving a stochastic approximation training algorithm, and development of a control system for our laboratory fermenter.

6. Predictive Control (M. Fikar)

Predictive control has been successful not only in academia but in industrial process applications as well. Its main drawbacks are the stability problems. The aim of this research is to enhance the basic input-output predictive methods. The problem is solved by means of the Youla-Kučera parameterisation of all stabilising controllers. Both finite and infinite horizon formulations are handled. Another approach is to assume that the loop is already controlled by a linear controller and to find the minimum number of control, or tracking error steps that leads to stable closed-loop behaviour. In all cases, it can be shown that the minimum number of steps is closely related to the number of unstable poles/zeros of the plant.

7. Dynamic Optimisation (M. Fikar)

Increased quality requirements in chemical and petrochemical industries call for more complicated and sophisticated control strategies. Moreover, there is a need to know the achievable limits of performance and speed of transient behaviour of processes. Optimal control theory is able to provide responses to these questions. In this research, changeover problems in multicomponent distillation are studied.

8. Modelling and control of chemical reactors, biochemical reactors, distillation columns and heat exchangers

The research of all research groups is focused on modelling and control of various types of chemical and biochemical processes.

V. COOPERATION

V.1 Cooperation in Slovakia

Department of Automatic Control Systems, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology, Bratislava

Department of Automation and Control, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology, Bratislava

Department of Automation and Measurement, Faculty of Mechanical Engineering, Slovak University of Technology, Bratislava

Institute of Control Theory and Robotics, Slovak Academy of Sciences, Bratislava

Department of Technical Cybernetics and Artificial Intelligence, Faculty of Electrical Engineering , Technical University of Košice, Košice

Department of Management and Control Engineering, BERG Faculty, Technical University of Košice, Košice

Slovnaft, Inc., Bratislava

NCHZ, Inc., Nováky

ProCS, Ltd., Šaľa

Fuzzy, Ltd., Diakovce

V.2 International Cooperation

Department of Process Control and Computer Techniques, University of Pardubice, Pardubice, Czech Republic
- Control system design

Department of Computing and Control Engineering, Prague Institute of Chemical Technology, Prague, Czech Republic
- Control system design

Department of Automatic Control, Faculty of Technology Zlín, Technical University Brno, Zlín, Czech Republic
- Adaptive control
- Robust control

Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic
- Polynomial synthesis
- Predictive control

Trnka Laboratory for Automatic Control, Faculty of Electrical Engineering, Czech Technical University, Prague, Czech Republic
- Adaptive control
- Predictive control

LSGC-CNRS, Ecole Nationale Superieure des Industries Chimiques (ENSIC), Nancy, France
- Dynamic optimisation of distillation columns
- Control of distillation columns

Ecole Nationale Superieure des Ingénieurs de Génie Chimique-Chemin de la Loge, Toulouse, France
- Neural networks
- Learning automata
- Predictive control

University of Bochum, Bochum, Germany
- Closed-loop identification
- Predictive control

University of Dortmund, Dortmund, Germany
- Predictive control

Technical University of Budapest, Budapest, Hungary
- Modelling of chemical processes

University of Veszprem, Hungary
- Environmental engineering
- Bioengineering projects

V.3 Membership in Domestic Organisations and Societies

Slovak Society of Cybernetics and Informatics, Bratislava (A. Mészáros, J. Mikleš)

Slovak Society of Chemical Engineering, Bratislava (M. Bakošová, J. Danko, J. Dvoran, M. Fikar, M. Karšaiová, J. Maťko, A. Mészáros, J. Mikleš, M. Ondrovičová, A. Zemanovičová)

Slovak Union of Industrial Chemistry, Science- technical Society, Bratislava (M. Bakošová, J. Danko, J. Dvoran, M. Fikar, M. Karšaiová, D. Lázničková, J. Maťko, A. Mészáros, J. Mikleš, M. Ondrovičová, A, Seč, A. Vasičkaninová, A. Zemanovičová, Ľ. Čirka, J. Dzivák, F. Jelenčiak, Š. Kožka, A. Rusnák)

V.4 Membership in International Organisations and Societies

International Federation of Automatic Control, Laxenburg, Austria (J. Mikleš)
European Federation of Biotechnology, Brussels, Belgium (A. Mészáros)
The New York Academy of Sciences, New York, USA (A. Mészáros)

V.5 International Scientific Programmes

1. INCO COPERNICUS

a) CP97:7010, The European Network for Industrial Application of Polynomial Design Methods – EUROPOLY
Coordinator at the FCT STU: J. Mikleš
Participants: Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic; University of Twente, Twente, Netherlands; University of Glasgow, Glasgow, Great Britain; Uppsala University, Uppsala, Sweden; University of Strathclyde, Strathclyde, Great Britain; Politecnico di Milano, Milan, Italy; CNRS – LAAS, Toulouse, France; Czech University of Technology, Prague, Czech Republic; Technical University of Brno, Brno, Czech Republic; Department of Process Control, Faculty of Chemical Technology, Slovak University of

Technology, Bratislava, Slovakia; Warsaw University of Technology, Warsaw, Poland; Swiss Federal Institute of Technology, Zurich, Switzerland; ProCS, Ltd., Šaľa, Slovakia; Compureg Plzeň, Plzeň, Czech Republic

Period: January 1998 – December 2000

2. Project of Austrian - Slovak Scientific Cooperation: Aktion Österreich - Slowakei

a) No. 26s12, Optimierung des Verbrennungsprocess von dem Standpunkt des Umweltschutzes (Optimisation of a Combustion Process from the Environmental Point of View)

Coordinator at the FCT STU: A. Zemanovičová

Participants: Faculty of Chemical Technology, Slovak University of technology, Bratislava, Slovakia; Technical University of Vienna, Vienna, Austria

Period: April 1999 – December 2000

V.6 Visitors from Abroad

Prof. R.R. Biglov	Lomonosov State Academy of Fine Chemical Technology, Moscow, Russia, June 1999 (2 days)
Prof. V.V. Burljaev	Lomonosov State Academy of Fine Chemical Technology, Moscow, Russia, June 1999 (2 days)
Dr. E.V. Burljaeva	Lomonosov State Academy of Fine Chemical Technology, Moscow, Russia, June 1999 (2 days)
Prof. P. Dostál	Faculty of Technology Zlín, Technical University of Brno, Zlín, Czech Republic, June 1999 (1 day)
Prof. H. Hofbauer	Technical University of Vienna, Vienna, Austria, September 1999 (3 days)
Prof. V. Kučera	Trnka Laboratory for Automatic Control, Faculty of Electrical Engineering, Czech Technical University, Prague, Czech Republic, May (1 day)
Prof. I. Machač	University of Pardubice, Pardubice, Czech Republic, January 1999 (1 day)
R. Prokop, PhD.	Faculty of Technology Zlín, Technical University of Brno, Zlín, Czech Republic, June 1999 (1 day)
Z. Prokopová, PhD.	Faculty of Technology Zlín, Technical University of Brno, Zlín, Czech Republic, June 1999 (1 day)
Prof. I. Taufer	University of Pardubice, Pardubice, Czech Republic, January 1999 (1 day)
Prof. I. Taufer	University of Pardubice, Pardubice, Czech Republic, June 1999 (1 day)

V.7 Visits of Staff Members and PhD Students to Foreign Institutions

Ľ. Čirka	University of Roma, Roma, Italy, June 1999 (17 days)
J. Dvoran	Technical University of Brno, Brno, Czech Republic, September 1999 (2 days)
M. Fikar	Conference ECC'99, Karlsruhe, Germany, August 31. – September 3. 1999
M. Fikar	Institute of Automation, Technical University of Brno, Brno, Czech Republic, February 1999 (1 day)
M. Fikar	Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic, January 1999 (3 days)
M. Fikar	Ruhr-University, Bochum, Germany, July-December 1999 (6 months)
M. Fikar	University of Enschede, Netherlands, October 1999 (1 day)
M. Fikar	University of Strathclyde, Glasgow, Great Britain, February 1999 (7 days)
J. Maťko	Technical University of Vienna, Vienna, Austria, June 1999 (1 day)
J. Maťko	Technical University of Vienna, Vienna, Austria, September 1999 (4 days)
A. Mészáros	Conference ESCAPE, Budapest, Hungary, May 31.– June 3. 1999
A. Mészáros	Technical University of Brno, Brno, Czech Republic, September 1999 (2 days)
A. Mészáros	Technical University of Vienna, Vienna, Austria, September 1999 (5 days)
A. Mészáros	Technological Education Institute of Piraeus, Athens, Greece, June - July 1999 (21 days)
A. Mészáros	University of Strathclyde, Glasgow, Great Britain, February 1999 (7 days)
J. Mikleš	Conference ECC'99, Karlsruhe, Germany, August 31. – September 3. 1999
J. Mikleš	Ruhr-University of Bochum, Bochum, Germany, June 1999 (24 days)
J. Mikleš	Technical University of Vienna, Vienna, Austria, May 1999 (1 day)
J. Mikleš	University of Strathclyde, Glasgow, Great Britain, February 1999 (7 days)
A. Zemanovičová	Technical University of Vienna, Vienna, Austria, June 1999 (1 day)

A. Zemanovičová	Technical University of Vienna, Vienna, Austria, November 1999 (2 days)
A. Zemanovičová	Technical University of Vienna, Vienna, Austria, October 1999 (1 month)
A. Zemanovičová	Technical University of Vienna, Vienna, Austria, September 1999 (1 day)

VI. THESES AND DISSERTATIONS

VI.1 Graduate Theses (MS Degree) for state examinations after five years of study (supervisors are written in brackets)

Andrášik A.:	Properties of an adaptive neural PID controller. (A. Mészáros)
Capek A.:	Design of a connection of a servo-drive laboratory model to a computer. (M. Fikar)
Krajčiová D.:	Decentralised control of a chemical reactor. (M. Karšaiová)
Roth P.:	PC control of a warm-air drying chamber (J. Danko)
Slíž D.:	PC control of a laboratory plate distillation column. (M. Bakošová)
Titka M.:	Identification and design of a fuzzy controller for CO_2 analyser. (A. Vasičkaninová)

VI.2 Habilitation Theses

Fikar M.:	Control of Processes of Chemical Technology with Constraints.

VII. PUBLICATIONS

VII.1 Journals

[1] Bakošová M., Grznárová G., Karšaiová M., Ondrovičová, M.: Riadenie etážovej rektifikačnej kolóny. Control of a plate distillation column (in Slovak). AT&P Journal 6 (3), 58 – 59, 63, (1999)

[2] Čirka Ľ., Mikleš J., Kožka Š..: Adaptívne riadenie s využitím parametrizovaných modelov (in Slovak). AT&P Journal 6 (3), 54-55, (1999)

[3] Danko J., Dzivák J.: Experimenálny model teplovzdušného výmenníka Experimental model of a heat exchanger (in Slovak). AT&P Journal 6 (3), 56-57, (1999)

[4] Dostál P., Bobál V, Fikar M.: One approach to adaptive control of a continuous stirred tank reactor. Selected Topics in Modelling and Control 2, 93 – 99, (1999)
[5] Dzivák J., Mikleš J., Jelenčiak F., Dvoran J.: Model rozkladového chemického reaktora. Model of a chemical reactor for decomposition reaction (in Slovak). AT&P Journal 6 (11), 56 – 57, (1999)
[6] Dzivák J., Mikleš J., Kožka Š., Jelenčiak F., Dvoran J.: Model of a chemical reactor for decomposition reaction. Selected Topics in Modelling and Control 2, 87 – 89, (1999)
[7]* Fikar M., Engell S., Dostál P.: Design of predictive LQ controller. Kybernetika 35 (4), 459 – 472 (1999)
[8]* Fikar M., Latifi M. A., Creff Y.: Optimal changeover profiles for an industrial depropanizer. Chemical Engineering Science 54 (13-14), 2715 – 2720 (1999)
[9] Fikar M., Kučera V.: On stable finite length control problem. Selected Topics in Modelling and Control 2, 1 – 5, (1999)
[10] Fikar M., Rusnák A., Mészáros A.: Riadenie biochemického reaktora pomocou iteratívneho dynamického programovania a neurónových sietí. Control of a biochemical reactor via iterative dynamic programming and neural network (in Slovak). AT&P Journal 6 (3), 27-28, (1999)
[11] Fikar M.: Návrh riadenia diskrétnych systémov s konečným počtom riadiacich zásahov. Control design for discrete systems with finite number of control actions (in Slovak). AT&P Journal 6 (11), 62 – 63, (1999)
[12] Greif G., Greifová M., Dvoran J., Karovičová J., Buchtová J.: Štúdium rastu a produkcie biogénnych amínov niektorými mikroorganizmami za modelových podmienok. Study of growth and production of biogenous amines by some microorganisms in model conditions (in Slovak). Czech J. Food Sci. 17 (1), 15 – 21 (1999). **(0,3)**
[13] Jelenčiak F., Mikleš J., Dvoran J., Dzivák J.: Analýza dynamických vlastností rozkladového chemického reaktora. Dynamic analysis of a chemical reactor for a decomposition reaction (in Slovak). AT&P Journal 6 (11), 58 – 59, (1999)
[14] Jelenčiak F., Mikleš J., Dvoran J., Dzivák J.: Dynamics of a chemical reactor for decomposition reaction. Selected Topics in Modelling and Control 2, 90 – 92, (1999)
[15] Lázničková, D., Dvoran, J.: Fuzzy riadenie prietokového chemického reaktora. Fuzzy control of a continuous-time stirred tank reactor (in Slovak). AT&P Journal 6 (11), 55,64, (1999)
[16]* Mészáros A., Rusnák A., Fikar M.: Adaptive neural PID control. Case Study: Tubular chemical reactor. Computers and Chemical Engineering 23, S847 – S850 (1999)

[17] Mészáros A., Rusnák A., Fikar M.: Adaptívne ladenie PID regulátora pomocou umelých neurónových sietí. Adaptive tuning of PID controller via artificial neural network (in Slovak). AT&P Journal 6 (3), 51-53, (1999)

[18] Mikleš J., Čirka Ľ., Kožka Š.: PID controller and LQ control design. Selected Topics in Modelling and Control 2, 19 – 23, (1999)

[19] Mikleš J., Fikar M., Mészáros A., Dzivák J., Jelenčiak F., Kožka Š.: Polynomial design methods applied to feedback control of a continuous stirred tank reactor. EUROPOLY Newsletter (3), 2 – 3 (1999)

[20] Prokop R., Bakošová M., Dostál P.: Decentralised control of chemical reactors based on delta model representation – a case study. Selected Topics in Modelling and Control 2, 81 – 86, (1999)

[21]* Rusnák A., Fikar M., Mészáros A.: Receding horizon control using modified iterative dynamic programming and neural network models. Computers and Chemical Engineering 23, S297 – S300 (1999)

[22] Vasičkaninová, A., Zemanovičová, A.: Fuzzy logic controller design for concentration system. Selected Topics in Modelling and Control 2, 106 – 111, (1999)

*VII.2 Conferences (*International conferences)*

[1]* Bakošová M., Karšaiová M., Ondrovičová M., Maťko J.: Adaptive λ-tracking of a distillation column. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 276-279

[2]* Bakošová M., Zemanovičová A., Karšaiová M.: High-purity Control of Distillation Columns. In: Proceedings of the 39th International Petroleum Conference, Bratislava, Slovak Republic, Sept. 20. – 23. 1999, vol. 2, p. H7.-1 - H7.-8

[3]* Čirka Ľ., Mikleš J., Kožka Š.: Enhancement of controllers via adaptive Q-feedback. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 273-275

[4]* Čirka Ľ., Mikleš J., Kožka Š.: Relationship between reactor uncertainties and feedback controller. In: Proceedings of the 26th International Conference of SSCHE, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, p. 116

[5] Čirka Ľ., Mikleš J., Kožka Š.: Vzťah neurčitostí reaktora a regulátora v spätnej väzbe. Relationship between reactor uncertainties and feedback controller (in Slovak). In: Proceedings of the 26th International Conference of SSCHI, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, CD ROM P37

[6] Čirka Ľ., Mikleš J., Seč A., Kožka Š.: Náplňová rektifikačná kolóna - Programové vybavenie. Stuffed distillation column – Software (in Slovak). In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 2, p. 149-151

[7]* Dzivák J., Mikleš J., Kožka Š., Jelenčiak F., Dvoran J.: Model of a continuous stirred tank reactor. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 155-157

[8]* Dzivák J., Mikleš J., Kožka Š., Jelenčiak F., Dvoran J.: Model of a continuous stirred tank reactor. In: Proceedings of the 26th International Conference of SSCHE, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, p. 114

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[10]* Fikar M., Morari M., Mikleš J.: On Youla-Kučera parameterisation approach to predictive control. In: Summaries Volume of the European Control Conference '99, Karlsruhe, Germany, Aug. 31. – Sept. 3. 1999, p. 912

[11]* Fikar M., Kučera V.: On stable finite length control problem. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 11–15

[12]* Fikar M., Morari M., Mikleš J.: On Youla-Kučera parameterisation approach to predictive control. In: Proceedings of the European Control Conference '99, Karlsruhe, Germany, Aug. 31. – Sept. 3. 1999, CD ROM, No. F163

[13]* Fikar M., Kučera V.: Polynomial Approach to Minimum Finite Length Control Problem. In: Proceedings of the 1st Workshop Polynomial Systems Theory and Applications, Glasgow, United Kingdom, Apr. 15. – 16. 1999, p. 73-78

[14]* Jelenčiak F., Mikleš J., Dvoran J., Dzivák J.: Dynamics of a class of a chemical reactor. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 158-160

[15]* Jelenčiak F., Mikleš J., Dvoran J., Dzivák J.: Dynamics of a class of a chemical reactor. In: Proceedings of the 26th International Conference of SSCHE, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, p. 113

[16] Jelenčiak F., Mikleš J., Dvoran J., Dzivák J.: Analýza dynamických vlastností chemického reaktora z hľadiska riadenia. Dynamics analysis of a chemical reactor from the control point of view (in Slovak). In: Proceedings of the 26th International Conference of SSCHI, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, CD ROM P34
[17] Jelenčiak F., Zemanovičová A.: Databázový systém zariadení pre globálne použitie ISSP-PGP. Data-base system of equipments for global using ISSP-PGP (in Slovak). In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 2, p. 220-223
[18]* Karšaiová M., Bakošová M., Ondrovičová M., Zemanovičová A.: Using Simulation Language Matlab in Control Design. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 56 – 59
[19]* Karšaiová M., Bakošová M., Ondrovičová M., Zemanovičová A.: Control design of Chemical Reactor. In: Proceedings of the 26th International Conference of SSCHE, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, p. 82
[20]* Karšaiová M., Bakošová M., Zemanovičová A., Dvoran J.: Optimisation and Control of Chemical Reactor In: Proceedings of the 39th International Petroleum Conference, Bratislava, Slovak Republic, Sept. 20. – 23. 1999, vol. 2, p. H9.-1 - H9.-7
[21]* Karšaiová M., Bakošová M., Ondrovičová M., Zemanovičová A.: Control design of Chemical Reactor. In: Proceedings of the 26th International Conference of SSCHI, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, CD ROM P2
[22]* Kožka Š., Mikleš J., Čirka Ľ.: Identification of chemical reactor via a dual Youla-Kučera parameterisation. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 91-94
[23]* Kožka Š., Mikleš J., Čirka Ľ., Jelenčiak F.: Identification of chemical reactor in closed-loop. In: Proceedings of the 26th International Conference of SSCHE, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, p. 115
[24]* Kožka Š., Mikleš J., Čirka Ľ., Jelenčiak F.: Identification of chemical reactor in closed-loop. In: Proceedings of the 26th International Conference of SSCHI, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, CD ROM P36
[25]* Mészáros A.: Determination of optimal feed rate profile in fed-batch bioreactors. In: Proceedings of the 26th International Conference of

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[28]* Mikleš, J., Čirka, Ľ., Kožka, Š.: PID controller and LQ control design. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 60 – 64

[29]* Mikleš, J., Kožka, Š., Mészáros, A., Fikar, M., Keseli, R.: An iterative scheme for identification and control design with application to a chemical reactor. In: Proceedings of the 1st Workshop Polynomial Systems Theory and Applications, Glasgow, United Kingdom, Apr. 15. – 16. 1999, p. 113-119

[30]* Ondrovičová M., Bakošová M., Karšaiová M.: Software GENIE for data acquisition and control of a Distillation column. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 309 - 312

[31]* Ondrovičová M., Bakošová M., Karšaiová M.: Using of Software GENIE for Data Acquisition and Control of a Laboratory Distillation Column. In: Proceedings of the 26th International Conference of SSCHE, Jasná, Demänovská dolina, Slovak Republic, May 24. – 28. 1999, p. 81

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[33]* Prokop R., Bakošová M., Dostál P.: Decentralised control of chemical reactors based on delta model representation – a case study. In: Proceedings of the 14th Triennial World Congress if the International Federation of Automatic Control, Beijing, People Republic of China, July 7. – 9. 1999, CD ROM vol. L, N. 5a-01-2, p. 181 – 186

[34] Seč A., Čirka Ľ., Andrášik A.: Náplňová rektifikačná kolóna – Matematický model. Stuffed distillation column – Mathematical model (in Slovak). In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 2, p. 141-144

[35] Seč A., Mikleš J., Čirka Ľ., Kožka Š.: Náplňová rektifikačná kolóna – Konštrukčná časť. Stuffed distillation column – Construction (in Slovak).

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[36]* Vasičkaninová A., Zemanovičová A.: Fuzzy logic controller design for concentration system. In: Proceedings of the 12th Conference Process Control '99, Tatranské Matliare, Slovak Republic, May 31. – June 3. 1999, vol. 1, p. 370 – 373

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VII.3 Books and Textbooks

[1] Mikleš J., Fikar M.: Modelovanie, identifikácia a riadenie procesov I. Modelling, identification, and Control of Processes (in Slovak). Publishing House of STU, Bratislava. 197 pp. (1999)

[2] Fikar M., Mikleš J.: Identifikácia systémov. System identification (in Slovak). Publishing House of STU, Bratislava. 114 pp. (1999)

[3] Fikar M. a kol.: Metódy počítačového spracovania dát. Computer Based Data Processing (in Slovak). Publishing House of STU, Bratislava. 105 pp. (1999)

VII.4 Patents

[1] Zemanovičová A., Zemanovič J.: Zapojenie prevzdušňovacieho systému bioreaktora. Connection of an airing system for a biochemical reactor (in Slovak). SK 279 785 (10.7.1999), Slovak Republic.