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

ANNUAL REPORT

1998

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I. STAFF

Head of the Department:

Prof. Ján Mikleš, PhD, DrSc.

Full Professor:

Ján Mikleš, PhD, DSc;

Associate Professors:

Ján Danko, PhD; Ján Dvoran, PhD; Alojz Mészáros, PhD;

Assistant Professors:

Monika Bakošová, PhD; Miroslav Fikar, PhD; Mária Karšaiová, PhD; Jozef Maťko; PhD; Magdaléna Ondrovičová; Andrej Seč; Anna Vasičkaninová; Anna Zemanovičová, PhD;

PhD students:

Abdouvakhob Abdoulaev; Ľuboš Čirka; Jozef Dzivák; František Jelenčiak; Štefan Kožka; Alica Nečasová; Anton Rusnák;

Technical staff:

Bibiána Filová; Eva Fuseková; Diana Malejčíková;

II. TEACHING AND RESEARCH LABORATORIES

A. 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)

B. 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 (MATLAB and toolboxes)

III. TEACHING

A. Undergraduate Study

2nd semester (spring)

Informatics	(1-2 h)	Bakošová, Fikar, Karšaiová, Vasičkaninová

5th semester (autumn)

Computer Based Data Evaluation	(0-2 h)	Bakošová, Čirka, Dzivák, Fikar, Jelenčiak, Karšaiová, Maťko, Ondrovičová, Seč, Vasičkaninová,

6th semester (spring)

Automatic Control Fundamentals	(2-0 h)	Danko, Mészáros
Laboratory Exercise of Automatic Control Fundamentals	(0-2 h)	Bakošová, Danko, Fikar, Karšaiová, Maťko, Ondrovičová, Rusnák, Seč, Vasičkaninová, Zemanovičová
Bachelor projects		

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)	Fikar
Laboratory Projects	(0-8 h)	Bakošová, Fikar, Karšaiová, Vasičkaninová, Zemanovičová

8th semester (spring)

Optimisation	(2-1 h)	Dvoran
Control Theory I	(2-2 h)	Mikleš, Čirka
Laboratory Exercises of Control Theory I	(0-2 h)	Čirka
Experimental Identification	(2-0 h)	Fikar, Mikleš
Laboratory Project II	(0-5 h)	Fikar, Mészáros, Mikleš
Modelling and Control of Polymerisation Processes	(2-2 h)	Dvoran
Process Dynamics	(2-0 h)	Bakošová
Laboratory Exercise		

of Process Dynamics	(0-1 h)	Bakošová

9th semester (autumn)

Control theory II	(2-0 h)	Mészáros
Intelligent Control Systems	(2-0 h)	Dvoran
Semestral Project	(0-10 h)	Dvoran, Karšaiová, Mészáros, Mikleš, Ondrovičová, Seč
CAD Systems	(2-0 h)	Karšaiová
Industrial Applications of Process Control	(2-0 h)	Mikleš
Process Dynamics	(2-0 h)	Bakošová
Laboratory Exercises of Process Dynamics	(0-1 h)	Bakošová
Control of Technological Processes	(1-2 h)	Bakošová
Control of Technological Processes in Inorganic Industry	(1-1 h)	Karšaiová

10th semester (spring)

Diploma Theses

B. 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

IV. CURRENT RESEARCH PROJECTS

A. Research Projects

1. Development of Control Methods (Ján Mikleš)

The problem of development and application of advanced control techniques for industrial processes is investigated. The main goals of the project can be formulated in the following items:

a) design of a CAD system for adaptive control of multivariable systems
b) development of a hierarchical control structure based on the neural network approach
c) control of systems with parametric and structural uncertainties

d) development of control methods of mechatronic systems for multiprocessor and multicomputer control systems
e) implementation of advanced control methods in industry

In the frame of this project, several important results were obtained. A predictive controller based on the Youla - Kučera parameterisation was created. It is a multivariable, piece-wise linear, time-variant controller and its predictive part is created by a finite impulse filter. A predictive control algorithm based on using of artificial neural networks (ANN) was developed. The algorithm uses ANN as a multistep feedforward predictor. A method of a closed-loop identification based on a fractional representation was developed. It is a method for the iterative identification from experimentally obtained data in a closed-loop and for the controller synthesis. This approach leads to a robust control system. New approaches for control of moving and mechatronic systems were developed. These approaches can manage also parasite properties of individual parts of control system, nonlinearities and parameter changes. New methods for analysis and synthesis of sensors, transmitters, amplifiers and controllers were also developed. New sensor systems were created for measuring of an acceleration and new propulsion systems with alternating motors. New methods were developed for planning of a courses in surroundings with obstacles. An original control design method was developed for nonlinear complex systems which mathematical models include uncertainties. The designed control guarantees closed-coop robustness and exponential stability with a pre-specified decay rate. The program package PREDICTOR was developed in simulation language MATLAB for predictive control of industrial process and technical systems. The package includes algorithms for generalised predictive control, continuous-time control and stabilising predictive control. They are also included recursive identification methods in it and so the suggested algorithms are adaptive ones. The Distributed Parameter Systems Toolbox for Matlab was also developed. The toolbox is proper for modelling, control and synthesis of systems with distributed parameters.

2. 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.

3. 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.

B. 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 (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, 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. Mészáros)

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.

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

A. Cooperation in Slovakia

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

Department of Automation and Control, Faculty of Electrical Engineering and Informatics, 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, 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

B. 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 and 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 and predictive control

LSGC-CNRS, Ecole Nationale Superieure des Industries Chimiques (ENSIC), Nancy, France
- Dynamic optimisation and 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

University of Dortmund, Dortmund, Germany
- Predictive control

Control Laboratory, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland
- Education and research in control engineering

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

University of Veszprem, Hungary
- Environmental engineering and bioengineering project

C. 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)

D. 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)

E. TEMPUS Programme

1. TEMPUS - S-JEP 11366-96, Flexible Learning and Continuing Education

J. Mikleš – coordinator at the FCT STU
Participants:
Slovak University of Technology, Faculty of Chemical Technology, Bratislava, Slovakia
Slovak University of Technology, Faculty of Electrical Engineering and Information, Bratislava, Slovakia
Fern Universität, Gesamthochschule in Hagen, Germany
Universita' di Roma Tre, Dipartimento di Informatica e Automazione, Italy
Institut de Recherche en Cybernetique de Nantes, France
Technological Education Institute Piraeus, Athens, Greece
Universidade Nova de Lisboa, Faculdade de Ciencias e Technologia, Portugal
Dublin City University, National Distance Education Centre, Ireland
Dublin City University, School of Mech. and Manufacturing Eng., Ireland
Matias Bel University, Faculty of Natural Sciences, Banská Bystrica, Slovakia
University of Transport and Communications, Faculty of Control, Žilina, Slovakia
ZEP SR, Bratislava, Slovakia
EUPU Nová Dubnica, Slovakia
National Centre of Distance Education, Bratislava, Slovakia
Period: September 1996 - August 1998
The main aims of this JEP are: to develop a modern Continuing Professional Development system and program for the university staff of the participating Slovak institutions for the development of Basic knowledge on 'flexible learning' and 'distance education', to develop

new distance education and inter/faculty courses on Mechatronics and Industrial Engineering, to establish laboratories of multimedia and telematics at the participating Slovak universities.

2. TEMPUS - IMG-97-SK-1017, Education in chemical process control

A. Mészáros
Participants:
Department of Process Control, Faculty of Chemical Technology, Slovak University of technology, Bratislava, Slovakia
Universitá Degli Studi di Roma „La Sapienzza“, Rome, Italy
Period: June 1998

F. International Scientific Programmes

1. Cooperation in Science and Research with CEEC/NIS: Institutional Partnership (Project of Swiss National Science Foundation)

a) 7IP 051791, Control Engineering Education and Research: A comparison of the actual situation in CZ, SK and CH and proposals for the future development
A. Mészáros - coordinator at the FCT STU
Participants:
Control Laboratory, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland
Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic
Trnka Laboratory for Automatic Control, Faculty of Electrical Engineering, Czech Technical University, Prague, Czech Republic
Department of Process Control, Faculty of Chemical Technology, Slovak University of technology, Bratislava, Slovakia
Period: October 1997 – December 1998

2. Project of Trilateral Cooperation Austria, Hungary and Slovakia

a) Regional Postgraduate Education in Environmental Engineering and Bioengineering
V. Báleš - coordinator at the FCT STU
Participants:
Faculty of Chemical Technology, Slovak University of technology, Bratislava, Slovakia

Technical University of Graz, Graz, Austria
University of Veszprem, Veszprem, Hungary
Period: October 1998 – December 1998

3. INCO COPERNICUS

a) CP97:7010, The European Network for Industrial Application of Polynomial Design Methods – EUROPOLY
J. Mikleš – coordinator at the FCT STU
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

G. Visitors from Abroad

Prof. H. Unbehauen	Ruhr University Bochum, Bochum, Germany, May 1998 (6 days)
Prof. P. Dostál	Faculty of Technology Zlín, Technical University of Brno, Zlín, Czech Republic, June 1998 (1 day)
Prof. Dr. Juraj Božičovič	Faculty of Chemical Engineering, University of Zagreb, Zagreb, Croatia, July 1998 (1 day)
Slavomir Stankov DrSc	Faculty of Natural Science, University of Split, Split, Croatia, July 1998 (1 day)

H. Visits of Staff Members and PhD Students to Foreign Institutions

M. Bakošová	Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic, February 1998 (4 days)

M. Bakošová	Conference Process Control, Kouty nad Desnou, Czech Republic, June 1998 (4 days)
M. Bakošová	Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, June - July 1998 (19 days)
M. Bakošová	Congress CHISA, Prague, Czech Republic, August 1998 (4 days)
Ľ. Čirka	Conference Process Control, Kouty nad Desnou, Czech Republic, June 1998 (4 days)
J. Dvoran	Universita Nova de Lisboa, Lisbon, Portugal, June – July 1998 (3 months)
J. Dvoran	Technical University of Ostrava, Ostrava, Czech Republic, September 1998 (2 days)
M. Fikar	Conference ESCAPE, Brugge, Belgium, May 1998 (6 days)
M. Fikar	Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic, February 1998 (4 days)
M. Fikar	Department of Automatic Control, Faculty of Technology Zlín, Technical M. University Brno, Zlín, Czech Republic, June 1998 (1 day)
M. Fikar	Conference Process Control, Kouty nad Desnou, Czech Republic, June 1998 (4 days)
M. Fikar	Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, June - July 1998 (19 days)
M. Fikar	Congress CHISA, Prague, Czech Republic, August 1998 (4 days)
M. Fikar	Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, November 1998 (7 days)
M. Fikar	Trnka Laboratory for Automatic Control, Faculty of Electrical Engineering, Czech Technical University, Prague, Czech Republic, December 1998 (1 day)
F. Jelenčiak	HUMUSOFT, Prague, Czech Republic, November 1998 (1 day)
D. Lázničková	ENSIC, Nancy, France, July 1998 (20 days)
J. Maťko	Technical University of Vienna, Vienna, Austria, September 1998 (1 day)
A. Mészáros	Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic, February 1998 (4 days)
A. Mészáros	Universita Degli Studi di Roma „La Sapienzza“, Rome, Italy, June 1998 (26 days)
A. Mészáros	Symposium ESBES, Porto, Portugal, September 1998 (7 days)

A. Mészáros	Technical University of Ostrava, Ostrava, Czech Republic, September 1998 (2 days)
A. Mészáros	Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, October – November 1998 (20 days)
A. Mészáros	University of Veszprem, Veszprem, Hungary, November 1998 (7 days)
J. Mikleš	Universita Nova de Lisboa, Lisbon, Portugal, April 1998 (13 days)
J. Mikleš	IFAC Symposium DYCOP, Kerkyra, Greece, June 1998 (6 days)
J. Mikleš	Magyar Cukor, Acs, Hungary, August 1998 (1 day)
J. Mikleš	Ecole Nationale Superieure des Industries Chimiques (ENSIC), Nancy, France, September 1998 (4 days)
A. Rusnák	Conference Process Control, Kouty nad Desnou, Czech Republic, June 1998 (4 days)
A. Zemanovičová	Technical University of Vienna, Vienna, Austria, September 1998 (1 day)

VI. THESES AND DISSERTATIONS

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

Dzivák J.:	Computer control of a warm air heat-exchanger (J. Danko)
Grznárová G.:	PC control of a tray distillation column (M. Bakošová)
Hvolka M.:	Hardware and software for control of a chemical reactor (J. Danko)
Jelenčiak F.:	Information system of devices for automation (A. Zemanovičová)
Kolener P.:	Data acquisition from a packed distillation column (A. Seč)
Michalčík M.:	Control of a gas mixture composition (A. Zemanovičová)
Prček B.:	Design of a control system for a real process by using of object oriented visual systems (A. Mészáros)
Řeřicha M.:	Closed-loop identification of a parameterised model of a chemical reactor (J. Mikleš)
Virág R.:	Optimal control of a biochemical process (A. Mészáros)

VII. PUBLICATIONS

A. Journals

[1] Bakošová M., Prokop R., Karšaiová M.: Decentralised adaptive approach to control of chemical reactors based on delta model representation. Selected Topics in Modelling and Control 1, 55-60 (1998)

[2] Čerňáková M., Ondrovičová M.: Short-run tests for determining harmful effects of PCB-containing engine oils on cells. Folia Microbiol. 43 (4), 417-420 (1998)

[3] Čerňáková M., Zemanovičová A.: Microbial activity of soil contamined with chlorinated phenol derivates. Folia Microbiol. 43 (4), 411-416 (1998)

[4] Dostál P., Dvoran J.: Adaptivní suboptimální řízení průtočného chemického reaktoru. Adaptive suboptimal control of continuous-time chemical reactor (in Czech). AT&P Journal 5 (11), 52-54, 1998

[5] Dostál P., Prokopová Z., Dvoran J.: Suboptimal LQ tracking problem. Selected Topics in Modelling and Control 1, 1-5 (1998)

[6] Dvoran J.: EXPO´98 Lisabon - exkluzívna reportáž pre AT&P Journal. EXPO'98 Lisbon - exclusive reportage for AT&P Journal (in Slovak). AT&P Journal 5 (8), 55-56 (1998).

[7] Dvoran J.: EXPO´98 Lisabon - automatizačné a informačné systémy v námornej doprave. EXPO'98 Lisbon – automatic and information systems in marine transport (in Slovak). AT&P Journal 5 (10), 48-49, (1998)

[8] Dvoran J.: EXPO´98 Lisabon - oceánografia a oceánografické informačné systémy v námornej doprave. EXPO'98 Lisbon – oceanography and oceanographic information systems in marine transport (in Slovak). AT&P Journal 5 (11), 38-39 (1998)

[9] Fikar M., Engell S., Mikleš J.: Design of predictive controller based upon Youla-Kučera parameterisation. Selected Topics in Modelling and Control 1, 6-11 (1998)

[10] Fikar M., Latifi M. A., Fournier F., Creff Y.: Control vector parameterisation versus iterative dynamic programming in dynamic optimisation of a distillation column. Computers Chem. Engng. 22, S625-S628 (1998)

[11] Fikar M., Mikleš J.: Dynamická optimalizácia procesov. Dynamic optimisation of processes (in Slovak). AT&P Journal 5 (3), 44-45 (1998)

[12] Fikar M.: Niektoré aspekty časovooptimálneho riadenia. Some aspects of time/optimal control (in Slovak). AT&P Journal 5 (11), 60-61, 1998

[13] Fikar, M., Latifi, M. A., Fournier, F., Creff, Y.: Application of Iterative Dynamic Programming to Optimal Control of a Distillation Column. Can. J. Chem. Eng., 76(12), 1110-1117, 1998.
[14] Fournier F., Fikar M., Latifi M. A.: Control vector parameterisation in optimal control of a batch electrochemical reactor. Chem. Biochem. Eng. Q. 12 (2), 81-85 (1998)
[15] Karšaiová M., Bakošová M., Zemanovičová A., Ondrovičová M.: Control structure of chemical reactor. Chemical Papers 52 (2), 102-106 (1998)
[16] Lednický P, Mészáros A.: Neural network modelling in optimisation of continuous fermentation processes. Bioprocess Engineering 18, 427-432 (1998)
[17] Mészáros A., Rusnák A.: Nové prístupy k riadeniu procesov na báze umelých neurónových sietí. New approaches to process control on the basis of artificial neural networks (in Slovak). AT&P Journal 5 (3), 39-40 (1998)
[18] Mikleš J., Čirka Ľ., Kožka Š.: Identifikácia v uzavretom obvode a adaptívne riadenie. Closed-loop identification and adaptive control (in Slovak). AT&P Journal 5 (11), 58-59, 1998
[19] Mikleš J., Kožka Š., Čirka Ľ.: LQ regulátory s integračnou činnosťou. LQ controllers with integral processing (in Slovak). AT&P Journal 5 (11), 50 -51 (1998)
[20] Mikleš J., Seč A., Fikar M.: Adaptive control of minimum-phase systems. Selected Topics in Modelling and Control 1, 68-71 (1998)
[21] Nečasová A., Danko J., Mészáros A.: Riadenie laboratórneho modelu zásobníkov kvapaliny. Control of a laboratory model of tanks for a liquid (in Slovak). AT&P Journal 5 (3), 46-47 (1998)
[22] Rusnák A., Najim K., Mészáros A., Fikar M.: Neural network based constrained predictive control using stochastic approximation Algorithm. Selected Topics in Modelling and Control 1, 107-112 (1998)
[23] Vasičkaninová A., Zemanovičová A.: Filtration of signals. Chemical Papers 52 (3), 131-135 (1998)
[24] Zemanovičová A., Jelenčiak F.: Informačný systém zariadení pre globálne použitie ISSP - PGP. Information system for global using ISSP – PGP (in Slovak). AT&P Journal 5 (11), 18-19, (1998)
[25] Zemanovičová A.: Dávkovanie plynov pri nadkritickom prietoku. Gas supplying at the sub-critical flow-rate (in Slovak). AT&P Journal 5 (3), 48-49 (1998)

*B Conferences (*International conferences)*

[1]* Bakošová M., Ondrovičová M., Karšaiová M.: Adaptive control of distillation columns using LV control configuration. In: Proceedings of

the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998,vol. 1, p.15-18

[2]* Bakošová M., Ondrovičová M.: Adaptive control of distillation columns - a case study. In: CD ROM of full texts of the 13th International Congress of Chemical and Process Engineering CHISA'98, Prague, Czech Republic, August 23.-28. 1998, No. 527

[3]* Bakošová M., Ondrovičová M.: Adaptive control of distillation columns - a case study. In: Summaries of the 13th International Congress of Chemical and Process Engineering CHISA'98, Prague, Czech Republic, August 23.-28. 1998, vol. 6, p. 51

[4]* Bakošová M., Zemanovičová A., Ondrovičová M., Karšaiová M.: Adaptive control design for distillation columns based on LV control configuration. In: CD ROM 25. International Conference SSCHI, Jasná - Demänovská dolina, Slovakia, May 25.-29. 1998, No. V 39

[5]* Fikar M., Latifi M. A., Creff Y.: Dynamic Optimisation of a highly nonlinear Depropanizer. In: CD ROM of full texts of the 13th International Congress of Chemical and Process Engineering CHISA'98, Prague, August 23.-28. 1998, No. 1207

[6]* Fikar M., Latifi M. A., Creff Y.: Dynamic Optimisation of a highly nonlinear Depropanizer. In: Summaries of the 13th International Congress of Chemical and Process Engineering CHISA'98. Prague, Czech Republic, August 23.-28. 1998, vol. 6, p. 68

[7]* Fikar M., Latifi M. A., Fournier F., Creff Y.: Dynamic Optimisation of a Binary Distillation Column. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 1, p.454-457

[8]* Fikar M., Latifi M. A., Creff Y.: Optimal changeover profiles for an industrial depropanizer. In: Proceedings of the 15th Int. Symposium ISCRE, Newport Beach, California, USA, September 13.-16. 1998, p. 234-235

[9]* Karšaiová M., Bakošová M., Ondrovičová M., Zemanovičová A.: Decentralised control method in robust control. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998,vol. 1, p.214-217

[10]* Karšaiová M., Bakošová M., Ondrovičová M., Zemanovičová A.: Hierarchical control system in robust control. In: CD ROM 25. International Conference SSCHI, Jasná - Demänovská dolina, Slovakia. May 25.-29. 1998,No. V 38

[11]* Latifi M. A., Fournier F., Fikar M., Valentin G.: Methodology of dynamic optimisation and optimal control of batch electrochemical reactors. In: Proceedings of the 15th Int. Symposium ISCRE, Newport Beach, California, USA, September 13.-16. 1998, p.228 - 229

[12]* Maťko J., Staroselská J.: Optimisation of sulphenax (2-MBT) production. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 1, p. 254

[13] Maťko J., Staroselská J.: Optimalizácia výroby sulfenaxu. Optimisation of sulphenax production (in Slovak). In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 2, p.161-165

[14]* Mészáros A., Rusnák A.: Neural network based modelling for predictive control of bioprocesses. In: Proceedings of the 2nd European Symposium on Biochemical Engineering Science, Porto, Portugal, September 16.-19. 1998, p. 270

[15]* Mészáros A.: Advanced methods in control of biochemical processes. In: Proceedings of Regional Course of Trilateral Cooperation Austria, Hungary and Slovakia „Environmental Engineering, Bioengineering and Risk Assessment", Bratislava, Slovakia, December 1998.

[16]* Mészáros A., Rusnák A., Fikar M.: Neural network based predictive control of a tubular chemical reactor. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998,vol. 1, p.255-258

[17] Mészáros A.: Súčasné možnosti riadenia procesov biochemickej technológie. (Modern approaches to the control of biochemical processes (in Slovak). In: CD ROM 25. International Conference SSCHI, Jasná - Demänovská dolina, Slovakia, May 25.-29. 1998,No. P48

[18]* Mikleš J., Čirka Ľ., Kožka Š.: Closed-loop identification and adaptive control. In: Proceedings of the 13th Int. Com on Automation in Mining ICAMS'98 and 13th Int. Conf. on Process Control and Signals ASRTP'98, High Tatras, Slovakia, September 8.-11. 1998, p. 419-422

[19]* Mikleš J., Čirka Ľ., Kožka Š.: Closed-loop system identification. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98. Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 1, p.259-262

[20]* Mikleš J., Čirka Ľ., Kožka Š.: Closed-loop identification with application to a chemical reactor. In: Preprints of the 5th IFAC Symposium on Dynamics and Control of Process Systems DYCOPS'98, Corfu, Greece, June 8.-10.1998, vol. 5, p. 233-238

[21]* Nečasová A., Mészáros A., Danko J.: Adaptive control of a laboratory storage tank system. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 1, p.282-285

[22]* Ondrovičová M., Bakošová M., Karšaiová M.: Design of control system for a laboratory distillation column. In: Proceedings of the 3rd Scientific -

Technical Conference Process Control ´98. Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 1, p.299-302

[23]* Ondrovičová M., Bakošová M., Karšaiová M.: Control system designed for a laboratory distillation column. In: CD ROM 25. Int. Int. SSCHI, Jasná - Demänovská dolina, Slovakia, May 25.-29. 1998, No. V 40

[24]* Rusnák A., Fikar M., Mészáros A.: Iterative dynamic programming based on artificial neural networks. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 1, p.349-352

[25] Rusnák A., Mészáros A., Danko J.: Riadenie laboratórneho fermentora. Control of a laboratory fermenter (in Slovak). In: CD ROM 25. Int. Conf. SSCHI, Jasná - Demänovská dolina, Slovakia, May 25.-29. 1998, No. V 41

[26]* Vasičkaninová A., Zemanovičová A.: Identification gaseous mixture preparation system In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98. Kouty nad Desnou, Czech Republic. June 7.-10. 1998, vol. 1, p.458-461

[27]* Zemanovičová A., Karšaiová M., Bakošová M.: Dynamic method for preparing calibration gas mixtures. In: CD ROM 25. Int. conf. SSCHI, Jasná - Demänovská dolina, Slovakia, May 25.-29. 1998, No. V 37

[28]* Zemanovičová A., Karšaiová M.: Measurement of characteristic variables combustion process. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98. Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 1, p. 434

[29] Zemanovičová A., Karšaiová M.: Meranie charakteristických veličín spaľovacieho procesu. In: Proceedings of the 3rd Scientific - Technical Conference Process Control ´98, Kouty nad Desnou, Czech Republic, June 7.-10. 1998, vol. 2, p.283-286

Books and Textbooks

[1] Mikleš J., Veselý V. (editors): Selected Topics in Modelling and Control. Vol.1. 1998, STU Bratislava.