SIAM®

Society for Industrial and Applied Mathematics

MINISYMPOSIA

Control of Large, Heterogeneous Computer Networks
Control in Dynamics and Mechanics
Convex Optimization in Control and Systems Theory
Control and Identification of Distributed Parameter Systems
Stochastic Control, Filtering and Estimation
Industrial and Aerospace Applications
Adaptive Control
Hybrid Event Systems
Discrete Event Systems
Robust Control
Computational and Algorithmic Methods in Control
Nonlinear Systems
Dynamic Programming
Control of Fluids

Third SIAM Conference on

Control and Its Applications

Sponsored by SIAM Activity Group on Control and Systems Theory

April 27-29, 1995
Adam's Mark Hotel
St. Louis, Missouri

PRELIMINARY PROGRAM

Contents

Deadline Dates

Hotel Reservation
Friday, March 24, 1995

Conference Preregistration
Friday April 14, 1995

Organizing Committee

John E. Lagnese (Chair)
Georgetown University

Bozenna Pasik-Duncan (Program Chair)
University of Kansas

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Boston University

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Ohio State University

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Irena M. Lasiecka
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University of Michigan, Ann Arbor

Steven E. Shreve
Carnegie Mellon University

Allan Tannenbaum
University of Minnesota, Minneapolis

Control and its Applications

AN INVITATION ...
Message from the Conference Chair

Dear Colleagues:

Welcome to Saint Louis and the **Third SIAM Conference on Control and Its Applications.**

The conference is organized around several major themes chosen to highlight both significant recent developments and challenging open questions in control and systems theories and applications. In the program, you will find nine invited presentations; 40 minisymposia; 23 sessions of contributed papers; and a poster session. These cover a wide range of interesting and timely topics. In particular, you will note a special emphasis at this conference on important issues in nonlinear systems and their control. I am sure you will agree that the conference has an exceptionally strong group of speakers in areas that should be of great interest to SIAM members in general and to SIAG/CST members in particular. Most of the credit for this goes to the members of the Organizing Committee, who were primarily responsible for the selection of plenary speakers and who took the lead in organizing the minisymposia. To these individuals and to all of you who organized minisymposia or agreed to present papers at the conference (representing over 30 countries), I offer my sincere gratitude. The success which I feel certain the conference will enjoy is due to you.

The Organizing Committee and I hope that the conference and your visit to St. Louis are stimulating, exciting and enjoyable. I look forward to seeing you there.

John E. Lagnese
Conference Chair

Funding Agency

SIAM would like to thank the National Science Foundation for its partial support in conducting this conference.

Get-Togethers

SIAM Farewell Reception
Saturday, April 29, 1995
5:30 – 7:00 PM
Rose Garden Room

Come join colleagues as you wrap up the conference over complimentary beer, wine, sodas, and hot and cold hors d'oeuveres.

Following are subject classifications for the sessions. The codes in parentheses designate session type and number. The session types are: contributed presentations (CP), invited presentations (IP), minisymposia (MS). For the poster presentations, see page 14.

Adaptive Control

Adaptive Control (CP9, page 10)
Stochastic Theory - Adaptive Control I and II (MS27 and MS39, pages 13 and 21)

Computer, Computational and Algorithmic Issues in Control

Advances in Computational Methods for Control and Systems I and II (MS7 and MS14, pages 5 and 7)
Computational and Numerical Methods in Control and Optimization I and II (CP15 and CP17, pages 13 and 19)
Numerical Methods in Stochastic Control (MS11, page 7)
Numerical Problems in Control Theory (MS30, page 18)

Control in Computers and Networks

Why is Controlling High-Speed Networks a Challenge? (IP2, page 4)

Control Applications to Finance/ Economics

Applications of Control Theory to Economic Theory (MS33, page 18)
Control Applications to Finance (MS20, page 10)

Control of Fluids

Control of Nonlinear Partial Differential Equations with Applications to Fluid Dynamics (IP7, page 20)
Control of Unsteady, Viscous Incompressible Flows (MS12, page 7)
Optimal Control of Fluids and Heat Conduction (MS5, page 5)

Control Theory and Medicine

Control Theory and Medicine (MS3, page 4)

Convex Optimization and Control

Convex Optimization in Control and Systems Theory (IP5, page 11)
Convex Optimization in Control Theory: Algorithms and Applications (MS19, page 9)
Control-Theoretic Applications of Convex Optimization (MS25, page 12)

Distributed Parameter Systems

Applications of PDE Control Methods I and II (MS29 and MS36, pages 18 and 21)
Control and Identification of Distributed Parameter Systems I, II and III (CP11, CP7 and CP18, pages 11, 10, and 19)
Control of Nonlinear Distributed Parameter Systems I, II and III (MS2, MS9, and MS16, pages 4, 6, and 9)
Inverse Problems for Semilinear Elliptic Equations (IP9, page 21)
Nonstandard Riccati Equations Arising in Boundary Control Problems (MS23, page 12)

Dynamical Systems and Control

Dynamical Systems and Their Associated Automata (IP1, page 4)
Nonlinear Systems and Control I and II (CP5 and CP13, pages 8 and 13)
Symmetry, Heteroclinic Cycles, Noise and Control (IP3, page 6)
Singular Perturbations in Control: Recent Developments (MS10, page 6)

H^∞/Robust Control

H^∞ and Robust Control I and II (CP6 and CP10, pages 8 and 11)
Nonlinear H^∞ Control and Viscosity Solutions (MS26, page 12)

Hybrid Systems

Modeling and Control for Hybrid Systems I and II (MS34 and MS40, pages 19 and 22)
Delay Systems and Hybrid Systems (CP3, page 6)

Industrial and Aerospace Applications

Aerospace Applications of Control Theory (MS21, page 10)
Chemical Process Control (MS28, page 13)
Industrial and Aerospace Applications I and II, CP19 and CP22, pages 19 and 22)

Linear Systems

Linear Systems (CP4, pages 8)
Feedback Systems and Feedback Control (CP16, page 14)
Stabilization and Robustness of Linear Systems (CP20, page 20)

Manufacturing Systems

Recent Advances in Control and Optimization of Manufacturing Systems I and II (MS6 and MS13, pages 5 and 7)

Mechanics and Control

Motion Planning I: Adaptive Control (MS1, page 4)
Motion Planning II: Nonholonomic Mechanics (MS8, page 6)
Mechanical Systems I and II (MS15 and MS22, pages 9 and 12)

Nonlinear Systems and Their Control

Combinatorial Methods in Nonlinear Control (MS35, page 19)
Differential Algebraic Formulations of Control Problems (MS17, page 9)
Optimal Control and Nonlinear Controllability I and II (MS24 and MS37, pages 12 and 21)
Sliding Mode Control of Large-Scale Systems (MS32, page 18)
State-Space and I/O Stabilization for Nonlinear Systems (IP8, page 20)
Stability and Robustness of Nonlinear Systems (CP2, page 6)

Optimal Control and Optimization

Nonsmooth Methods in Optimal Control (MS38, page 21)
Optimal Control and Optimization I and II (CP8 and CP12, pages 10 and 13)

Stochastic Control and Related Topics

Connecting Risk Sensitive Control Problems and Deterministic Games Through Singular Perturbations (IP4, page 11)
Diffusion Approximations of Control Queueing Theory (MS4, page 5)
Parametric Uncertainty and Performance (MS18, page 9)
Singular Perturbations of Controlled Markov Processes and Applications (MS31, page 18)
Stochastic Systems (CP1, page 5)
Stochastic Control, Filtering and Estimation (CP23, page 22)
Viscosity Solutions and Their Applications (IP6, page 11)

Systems Theory and Applications

Fuzzy Systems and Intelligent Control (CP21, page 22)
Systems Theory and Applications (CP14, page 13)

7:00/St. Louis Ballroom Foyer

Registration Opens

7:45/St. Louis D

Opening Remarks and Announcements

John E. Lagnese, Georgetown University

8:00/St. Louis D

IP1/Chair: Anthony M. Bloch, Ohio State University

Dynamical Systems and Their Associated Automata

In this talk, the speaker will consider problems related to the construction of a robust correspondence between an automaton and a continuous time dynamical system of the input-output type. Using methods based on ideas from topology, he will give a suitable characterization of appropriate input spaces and input coding schemes. As compared with the standard digital electronics paradigm, these results provide a more generally applicable conceptual scheme for building robustness into a calculational mechanism. The results obtained suggest new ways to interpret neurobiological signals and neurobiological signal processing.

Roger W. Brockett
McKay Laboratory, Harvard University

9:00/St. Louis D

IP2/Chair: Marc Q. Jacobs, Air Force Office of Scientific Research

Why Is Controlling High-Speed Networks a Challenge?

Network speeds have been increasing rapidly, mainly due to advances in hardware. Gigabit networks capable of transmitting billions of bits per second are already operational. However, the higher the speed of a network, the harder it is to control the network. With increased networking speed, the burstiness of carried traffic increases and so does speed mismatch between subnetworks. New control techniques are needed to manage traffic congestion while ensuring high network utilization.

These new control schemes must be fast in responding to rapidly changing traffic load, robust in the presence of possible transient errors, and cheap in implementation cost and control overhead. In addition, the control should be self-configuring and adaptive. The networking service should require absolutely no *a priori* "contract" with end users, so that they can send any traffic to the network at any time. That is, users should be able to use these future high-speed networks as easily as they use today's local area networks.

In this presentation, the speaker will describe some recent advances in addressing a number of control methods and their applications to an ATM (Asynchronous Transfer Mode) network, currently under joint development by Harvard and its industrial partners.

Hans T. Kung
Division of Applied Sciences
Harvard University

10:00/St. Louis E

Coffee

10:30 AM-12:30 PM

Concurrent Sessions

MS1/St. Louis D

Motion Planning/Optimal Control (Part I of II)

In these minisymposia, related aspects of motion planning, nonholonomic mechanics and optimal control will be discussed. Nonholonomic mechanics classically describes the motion of mechanical systems with nonintegrable constraints, such as constraints of sliding and rolling. Control of such systems is of importance in robotic motion and the motion of wheeled vehicles. Motion planning for such systems is of great interest and ideas of this sort extend to other applications such as medical endoscopy. One can consider optimal control problems for such mechanical systems, but in fact optimal control problems with nonholonomic constraints also arise naturally in nonlinear kinematic problems where the number of controls is less than the dimension of the state space. These are often called variational nonholonomic problems.

Organizers: Anthony M. Bloch, Ohio State University and University of Michigan, Ann Arbor; John Baillieul, Boston University and Peter E. Crouch, Arizona State University

10:30 Optimal Control and the Lagrange Problem
Anthony M. Bloch and Peter E. Crouch, Organizers

11:00 On Second or Necessary and Sufficient Conditions for Optimal Control Problems
Peter E. Crouch, Organizer and S. Nikitin, Arizona State University

11:30 The Singular Curves Determine the System
Richard Montgomery, University of California, Santa Cruz

12:00 Differential-geometric Aspects of the Maximum Principle of Optimal Control Theory
Hector J. Sussmann, Rutgers University

MS2/Rose Garden Room

Control of Nonlinear Distributed Parameter Systems (Part I of III)

This minisymposium will focus on control and optimization problems of dynamic physical processes formulated in the context of nonlinear partial differential equations (distributed parameter systems). The speakers will present an overview of current research methodologies in various areas of modern control theory including (i) controllability/stabilizability of systems arising in continuous mechanics; (ii) existence/uniqueness and optimality conditions for various nonlinear (and nonconvex) control problems arising in chemical reaction processes, electromagnetism, etc; (iii) optimal control in fluid dynamics; (iv) control problems with free boundaries; and (v) Hamilton Jacobi equations for PDE's and their applications.

The solution to these problems hinges on modern mathematical methods (functional analysis, operator theory, partial differential equations, nonlinear analysis, and optimization) developed in the context of control theory. Applications of these techniques can be found in areas such as space structures, aeronautics, robotics, petroleum industry, automobile industry, chemical processes, and environmental sciences.

Organizer: Irena M. Lasiecka, University of Virginia

10:30 Boundary Stabilization of Maxwell's Equations and of Related Evolutionary Systems
Vilmos Komornik, Université Louis Pasteur, France

11:00 Existence of Optimal Controls without Convexity
Thomas Seidman, University of Maryland, Baltimore County

11:30 Nonlinear Transmission Conditions in Networks of Strings and Beams
Guenter Leugering, Universität Bayreuth, Germany

12:00 Optimal Control of the Convective Velocity in a Fluid Flow Problem
Suzanne Lenhart, University of Tennessee, Knoxville

MS3/St. Louis A

Control Theory and Medicine

Medical applications of control theory have traditionally been restricted to prothesis design, but, in the last few years, numerous applications have begun to appear, for example, the seminal work of Anderson and May in the applications of control theory to infectious disease and the modeling of tumor growth. The speakers in this minisymposium will present four current applications of control theory to problems in the area of the control of infectious diseases, prediction of stress fractures in the lower leg, cardiac arrhythmia and visual perception. The purpose of this minisymposium is to present to an audience of mathematical control theorists a few of the emerging applications of control theory to medicine. Some of the applications are intensely mathematical, such as the prediction of stress fracture and cardiac arrhythmia, and some will require new mathematical tools, such as some of the applications to disease control. Some of the new applications are very much related to classical control theory, for example, some of the problems associated with vision have models which are low dimensional, highly nonlinear systems.

Clyde F. Martin, Texas Tech University

10:30 On the Problem of Active Vision and Spatial Reasoning
Bijoy K. Ghosh, Washington University

11:00 Control Theoretic Models of the Lower Leg Bone-Muscle Complex
Lawrence Schovanec, Texas Tech University

11:30 Mathematical Model and Analysis of the Human Respiratory Control System
Hein T. Tran, North Carolina State University

12:00 Vaccination Policies for Infectious Diseases: Control with Limited Resources
Clyde F. Martin, Organizer, Linda Allen and David Noga, Texas Tech University

10:30 AM-12:30 PM

Concurrent Sessions

MS4/St. Louis B

Diffusion Approximations of Control Queueing Theory

The controlled queueing systems arising in computer communications and flexible manufacturing, have multiple types of customers at each station. In the semiconductor industry, there are often many stations and two to three times as many customers; decisions of routing and sequencing have to be made at each station. While the queueing models are typically too complicated to be analyzed directly, there is considerable evidence that Brownian networks provide an effective approximations to them under heavy traffic conditions. The speakers will present some results on theoretical convergence issues, performance of sequencing rule and numerical approximations.

Organizers: L. Felipe Martins, Cleveland State University and H. Mete Soner, Carnegie Mellon University

10:30 Scheduling Closed Two-Station Queueing Networks
P.R. Kumar, University of Illinois, Champaign

11:00 Large Deviation Approximations for Queueing Networks
Paul G. Dupuis, Brown University

11:30 Controlled Routing in Large Trunk Line Networks
Harold Kusbner and Jichuan Yang, Brown University

12:00 Multiclass Queueing Networks in Heavy Traffic: A Weak Convergence Approach
L. Felipe Martins, Organizer and Harold Kushner, Brown University

MS5/St. Louis C

Optimal Control of Fluids and Heat Conduction

Optimal control of fluids and heat conduction arise in many interesting and important applications, some of which will be discussed by the speakers. The control problems are governed by systems of nonlinear partial differential equation, and the nonlinearities and coupling of differential equations lead to challenging theoretical and numerical problems. The speakers will describe these problems and their solutions, the approximation and numerical solution of the optimal control problems, and example of commercially important applications.

Organizers: Matthias Heinkenschloss, Virginia Polytechnic Institute and State University and Ekkehard W. Sachs, Universität Trier, Germany

10:30 Control of Fluid/Structure Interactions
H. T. Banks, North Carolina State University

11:00 Shape Optimization Problems for the Navier-Stokes Equations
John Burkhardt, *Max D. Gunzburger*, Virginia Polytechnic Institute and State University; Hongchul Kim, Seoul National University, Korea; and Janet Peterson, Virginia Polytechnic Institute and State University

11:30 Optimization Methods in the Control of Industrial Furnaces
Heidi Jager, Universitat Trier, Germany and *Ekkehard W. Sachs*, Organizer

12:00 Multilevel Iterative Methods for Nonlinear Optimal Control Problems
Matthias Heinkenschloss, Organizer

MS6/St. Louis F

Recent Advances in Control and Optimization of Manufacturing Systems (Part I of II)

In recent years, there has been rapid progress in research of manufacturing systems. Many important results have been obtained with significant impact on applications. In the competitive world, research in mathematical and computational sciences plays an important role in creating and improving technologies and management practices of manufacturing systems.

In this minisymposium, the speakers will address several current research topics, including hierarchical and robust production planning in stochastic manufacturing systems, match-up stochastic scheduling strategies, and instability in scheduling manufacturing systems. In addition, they will describe the impact of the underlying study on many applications in manufacturing systems.

Organizers: George Yin, Wayne State University and Qing Zhang, University of Georgia

10:30 Hierarchical Controls in Stochastic Manufacturing Systems: A Review
Suresh Sethi, University of Toronto, Canada

11:00 Discretizations and Bounds for Match-Up Stochastic Scheduling Strategies
John Birge, University of Michigan, Ann Arbor

11:30 Robust Production and Maintenance Planning in Stochastic Manufacturing Systems
E.K. Boukas, École Polytechnique de Montréal, Canada; *Qing Zhang* and George Yin, Organizers

12:00 The Role of Instability Examples in Scheduling Manufacturing Systems
Thomas Seidman, University of Maryland, Baltimore County

MS7/St. Louis G

Recent Advances in Computational Methods for Control and Systems (Part I of II)

(This session will run until 1:00 PM).

Progress has been made in recent years in computational methods for control problems and research in this area continues to thrive. The speakers in these sessions, come from a variety of disciplines — electrical engineering, applied mathematics and computer science. All have made notable contributions in the computational aspects of control theory. They will present an overview of some of the aspects of current research in this area, including large-scale and parallel computations.

Organizer: Biswa Nath Datta, Northern Illinois University

Co-Chair: Pradeep Misra, Wright State University

10:30 Parallel Algorithms for Matrix Equations Arising in Control
Biswa Nath Datta, Organizer

11:00 Eigenvalue Assignment Algorithms and Numerical Stability
Rajnikant V. Patel, Concordia University, Canada and Pradeep Misra, Co-chair

11:30 Condition Estimation for Matrix Functions
Roy C. Mathias, College of William and Mary

12:00 Computational Aspects of Finding Stability Robustness Bounds for State Space Model with Structured Uncertainty
Judy Gardiner, Ohio State University, Columbus

12:30 On the Conditioning of the Single-Input Eigenvalue Assignment Problem
Mark Arnold, University of Arkansas, Fayetteville

CP1/Directors Row 46

Stochastic Systems

Chair: Sean P. Meyn, University of Illinois, Urbana

10:30 Sufficient Conditions of Optimality for Controlled Diffusions
Xun Yu Zhou, Chinese University of Hong Kong, Hong Kong

10:50 On Some LMI's Arising in Stochastic Control
Edwin Engin Yaz, University of Arkansas, Fayetteville; and Yvonne Ilke Yaz, Centenary College

11:10 Guaranteed Optimal Control of Stochastic Systems with Information Structure Constraints
Sergey V. Savastyuk and Dragoslav Siljak, Santa Clara University

11:30 Application of the Stochastic Artstein Theorem to the Feedback Stabilization of Stochastic Systems
Erik I. Verriest, Georgia Tech Lorraine, France; and Patrick Florchinger, Université de Metz, France

11:50 Feedback Stabilization of Affine in the Control Stochastic Differential Systems by the Control Lyapunov Function Method
Patrick Florchinger, Université de Metz, France

12:10 Transience of Multiclass Queueing Networks via Fluid Limit Models
Sean P. Meyn, University of Illinois, Urbana

10:30 AM-12:30 PM

Concurrent Sessions

CP2/Directors Row 43

Stability and Robustness of Nonlinear Systems

Chair: Wei Lin, Washington University

10:30 High-Order Robust Control Scheme for Nonlinear Jump System
E.K. Boukas and H. Yang, École Polytechnique de Montréal, Canada

10:50 Global Output Feedback Stabilization of Euler-Lagrange Systems with Non-Dissipative Forces
Serge Shishkin, Russian Academy of Sciences, Russia; *Romeo Ortega*, Université de Technologie de Compiegne, France; and David Hill, Sydney University, Australia

11:10 Feedback Stabilization in the Large for Non-Affine Nonlinear Systems with Stable Free Dynamics
Wei Lin, Washington University

11:30 A State Space Linear Matrix Inequality Approach to Nonlinear Robustness Analysis
Xin Chen and John T. Wen, Rensselaer Polytechnic Institute

11:50 Global Stability and Stabilizability of Nonlinear Triangular Systems
Peter Seibert and *Rodolfo Suarez*, Universidad Autonoma Metropolitana-Iztapalapa, Mexico

12:10 Sliding Mode Stabilization of Uncertain Nonlinear System
Alexander G. Luk'yanov, Institute of Control Sciences, Russia

CP3/Directors Row 26

Delay Systems and Hybrid Systems

Chair: Brad Lehman, Mississippi State University

10:30 Overtaking Optimal Solutions for Variational Problems with Time Delays
Dean A. Carlson, University of Toledo

10:50 Stability in Delay Equations with Perturbed Time Lags
Janos Turi, University of Texas, Dallas

11:10 Vibrational Periodic Controllers for Systems with Controller Delay
Khalil Shujaee and Brad Lehman, Mississippi State University

11:30 Microchaos in Controlled Mechanical Systems
Gabor Stepan, California Institute of Technology; Gyorgy Haller, Brown University; and Eniko Enikov, University of Illinois, Chicago

11:50 Robustness Issues in Hybrid Systems
Charles Horn, S.R. Kulkarni and Peter Ramadge, Princeton University

12:30

Lunch

2:00/St. Louis D

IP3/Chair: John Baillieul, Boston University

Symmetry, Heteroclinic Cycles, Noise and Control

In the first part of the presentation, the speaker will describe how discrete and continuous groups of symmetries inherited from the symmetries of physical problems, can "stabilize" phenomena which are typically rare and structurally unstable. In particular, he will describe a class of systems which possess heteroclinic attractors: cycles connecting saddle type equilibria. Such cycles produce solutions which exhibit intermittent behavior consisting of quiescent periods interrupted by rapid "bursts". In the second part, the speaker will describe a control strategy for such systems. He will show that suitable feedback control can retain solutions near the saddle points and hence reduce the typical bursting rate. The models studied and the form of control are motivated by an interest in reducing turbulence production in the boundary layer, low dimensional models of which fall into the class of systems to be described.

Philip Holmes
Program in Applied and Computational Mathematics, and Department of Mechanical and Aerospace Engineering, Princeton University

3:00/St. Louis E

Coffee

3:30-5:30

Concurrent Sessions

MS8/St. Louis D

Motion Planning/Nonholonomic Mechanics (Part II of II)

(For description, see MS1, page 4)

Organizers: Anthony M. Bloch
Ohio State University and University of Michigan, Ann Arbor; John Baillieul, Boston University and N. Harris McClamroch, University of Michigan, Ann Arbor

3:30 The Interpolation of Gross Motions for Super-articulated Mechanical Systems
John Baillieul, Organizer

4:00 Sensor Based Motion Planning
Joel Burdick, California Institute of Technology

4:30 Oscillations, Constrained Systems, and Motion Control
P. S. Krishnaprasad, University of Maryland, College Park

5:00 Feedback Reorientation of Planar Multibody Systems in Space Using Joint Actuation
N. Harris McClamroch, Organizer and I. Kolmonovsky, University of Michigan, Ann Arbor

MS9/Rose Garden Room

Control of Nonlinear Distributed Parameter Systems (Part II of III)

(For description see MS2, page 4)

Organizer: Irena M. Lasiecka
University of Virginia

3:30 Suboptimal Feedback Control of the Stefan Problem by Convex Analysis Techniques
Karl Kunish, Universtät Berlin, Germany

4:00 On the Control of 3-Dimensional Turbulent Flows
Roger Temam, Indiana University, Bloomington

4:30 Design and Control Problems in Elastic Formation Theory
David Russell, Virginia Polytechnic Institute and State University

5:00 Convexity Properties of the Minimum Function in Infinite Dimensions
Piermarco Cannarsa, Università di Roma "Tor Vergata", Italy

MS10/St. Louis A

Singular Perturbations Methods in Control: Recent Developments

(This session will run until 6:00 PM).
Problems of control of systems including slow and fast motions (singularly perturbed systems - SPS) arise in many applications and are approached with the help of different asymptotic techniques which have been intensively studied during recent years. This minisymposium will focus on two major techniques in which progress has been made, boundary layer method and the averaging method. The speakers will present new results about extensions of both methods as well as their applicability to control of specific SPS.

3:30-5:30

Concurrent Sessions

Organizer: Vladimir Gaitsgory
University of South Australia, Australia

3:30 **Controlling Slow and Fast Dynamics**
Zvi Artstein, The Weizmann Institute of Science, Israel

4:00 **On the Behavior of Singularly Perturbed Systems which Contain Marginally Stable Boundary Layer Systems**
Martin Corless, Purdue University, West Lafayette; and Dong Ma, Cummins Engine Company, Inc.

4:30 **Controllability Properties of Differential Inclusions**
Goetz Grammel, Universität Augsburg, Germany

5:00 **Model Simplification for Switching Systems via Singular Perturbations**
Zigang Pan and Tamer Basar, University of Illinois, Urbana

5:30 **On Singular Perturbations in Dynamic and Differential Games**
Vladimir Gaitsgory, Organizer

MS11/St. Louis B

Numerical Methods in Stochastic Control

The theory of nonlinear stochastic optimal control, already well developed for certain classical problems, continues to attract attention and make progress. Interesting and important new applications can be found in problems from areas such as manufacturing and finance. The variety of problem formulations is also expanding, as evidenced by the interest in problems involving singular control and risk—sensitive control, as well as control of stochastic PDE. For many of these problems, numerical solutions are the best that one can hope for. At the same time, our level of understanding and experience with good computation methods is still quite limited.

There are (at least) three issues of interest when considering computational methods for stochastic control: the development of algorithms, proofs of convergence, and the actual implementation of an algorithm. In this minisymposium, the speakers will focus on the first and third topics.

Organizer: Paul G. Dupuis
Brown University

3:30 **Domain Decomposition Methods for Stochastic Control Problems**
Harold J. Kushner, Brown University

4:00 **Computational Stochastic Dynamic Programming: Groundwater Pollution Control Application**
Floyd Hanson and John J. Westman, University of Illinois, Chicago

4:30 **Numerical Methods for Queueing Systems in Heavy Traffic**
L. Felipe Martins, Cleveland State University

5:00 **Computational Methods for Small Noise Control Problems**
Paul G. Dupuis, Organizer and Dennis Jarvis, Brown University

MS12/St. Louis C

Control of Unsteady, Viscous Incompressible Flows

The speakers will address various analytical and computational aspects of control problems for unsteady, viscous incompressible flows. These control problems have a wide range of engineering and technological applications. In recent years, progress has been made in the modeling, analysis and computation of optimal and feedback controls for incompressible flows. This makes it possible to apply optimal and feedback control techniques to practical and complicated engineering designs and sophisticated real-time control systems. The speakers will discuss modeling and analysis of boundary optimal control; numerical methods and simulation of feedback control; long time behavior for optimal control and feedback control solutions; and numerical methods and simulation of boundary and distributed optimal control.

Organizer: L. Steven Hou
York University, Canada

3:30 **Boundary Value Problems and Optimal Boundary Control for the Navier-Stokes System**
Andrei V. Fursikov, Moscow State University; *Max D. Gunzburger*, Virginia Polytechnic Institute and State University; and L. Steven Hou, Organizer

4:00 **A Computational Study of Some Control Problems in Incompressible Flows**
L. Steven Hou, Organizer and *S.S. Ravindran*, North Carolina State University

4:30 **Dynamics for the Controlled Navier-Stokes Equations**
L. Steven Hou, Organizer and *Yin Yan*, Virginia Polytechnic Institute and State University

5:00 **Stabilization of Unsteady Flows**
Hyung-Chun Lee, University of California, Irvine

MS13/St. Louis F

Recent Advances in Control and Optimization of Manufacturing Systems (Part II of II)

For description, see MS6, page 5)

Organizers:George Yin, Wayne State University; and Qing Zhang, University of Georgia

3:30 **New Results and Open Problems in the Theory of Improvability for Production Systems**
C.-T. Kuo, J.-T. Lim and *Semyon Meerkov*, University of Michigan, Ann Arbor

4:00 **Optimal Control of Manufacturing Systems with Buffer Holding Costs**
James Perkins, Boston University

4:30 **Asymptotic Optimal Production Policies in Stochastic Two-machine Flowshops with Finite-size Buffers**
Xunyu Zhou and Ngo-Tai Fong, The Chinese University of Hong Kong, Hong Kong

5:00 **Lot-Streaming in Job-Shop Scheduling**
Stephane Dauzere-Peres, École des Mines de Nantes, France; and *Jean B. Lasserre*, LAAS-CNRS, France

MS14/St. Louis G

Recent Advances in Computational Methods for Control and Systems (Part II of II)

(This session will run until 6:30 PM).

(For description, see MS7, Page 5)

Organizer: Biswa Nath Datta, Northern Illinois University

Co-Chair: Pradeep Misra, Wright State University

3:30 **Robust Eigenvalue Assignment in State Feedback**
Chandante Hetti, Northern Illinois University and Biswa Nath Datta, Organizer

4:00 **Stable Computation of Characteristic Polynomials**
Pradeep Misra, Co-Chair and Paul Van Dooren, CESAME, Katholieke Universiteit de Leuven, Belgium

4:30 **Eigenstructure Assignment in Robust Control**
George Miminis, Memorial University of New Foundland, Canada

5:00 **An Algorithm on Regularization of Singular Systems by Derivative and Proportional Output Feedback**
Daniel Ho, H.C. Chan, Hong Kong Polytechnic, Hong Kong; and D.L. Chu, National Tsing Hua University, Taiwan

5:30 **Convergence of Direct Methods for Statistic Dynamic Programming**
Floyd Hanson, University of Illinois, Chicago; and K. Naimipour, Northeastern Illinois University

6:00 **Matrix Equation and Feedback Stabilization**
Karabi Datta and Yoo Pyo Hong, Northern Illinois University

3:30-5:30

Concurrent Sessions

CP4/Directors Row 46

Linear Systems

Chair: Renee Koplon, Wright State University

3:30 **Sructure at Infinity for Linear Infinite Dimensional Systems**
Rabah Rabah, École des Mines de Nantes, France; and Michel Malabra, Université de Nantes, France

3:50 **All Solutions of a General Algebraic Riccati Equation for Infinite-Dimensional Systems**
Rianne C.R. Kuiper, University of Twente, The Netherlands

4:10 **On the Static Output Feedback Pole Assignment of Linear Systems**
Xiaochang Alex Wang, Texas Tech University

4:30 **A Method of Parameter Identification for Perspective Systems and its Application to Machine Vision**
Edward P. Loucks, Chiron Corporation, St. Louis; and Bijoy K. Ghosh, Washington University

4:50 **Output-Restricted Linear Systems in Series with Linear Systems**
Renee Koplon, Wright State University

5:10 **On a Compact Solution of the Output-Zeroing Problem for MIMO Continuous Systems**
Jerzy Tokarzewski, Military University of Technology, Poland

CP5/Directors Row 43

Nonlinear Systems and Control I

Chair: Viswanath Ramakrishna, Princeton University

3:30 **Research Algorithms of Nonlinear Dynamical Systems with Several Controlling Parameters**
Konstantin V. Avramov and V.N. Karaban, Kharkov Polytechnic University, Ukraine

3:50 **Control of Bursting in Models of a Turbulent Boundary Layer**
Brian D. Coller and Philip Holmes, Princeton University; and John L. Lumley, Cornell University

4:10 **Nonlinear Design Problems — Despite The Non-existence of Relative Degrees at Isolated Points**
Vishwanath Ramakrishna, Princeton University

4:30 **Zubov Theorem and Domain of Attraction for Controlled Dynamic Systems**
Wei Kang, Naval Postgraduate School

4:50 **On the Controllability Regions of the Lorenz System Controlled by Input-State Linearization**
Salvatore Baglio, Luigi Fortuna and C. Vinci, Università di Catania, Italy

5:10 **Stability and Control of Hypercyclically Organized System (HOS). Application in Economics**
Mikhail V. Kuz'min, Foundation of Scientific & Cultural Development, Ukraine

5:30 **Speed-Gradient Control of Nonlinear Periodic and Chaotic Oscillations**
Alexander L. Fradkov, Russian Academy of Sciences, Russia; and Alexander Yu. Pogromsky, Baltic State Technical University, Russia

CP6/Directors Row 26

H^∞ and Robust Control I

Chair: Kathryn E. Lenz, University of Minnesota, Duluth

3:30 **The H_∞ Control Problem of Nonlinear, Partially Observed Systems: Differential Games and Viscosity Solutions**
Pierpaolo Soravia, University of California, Santa Barbara

3:50 **Parameter-Dependent Lyapunov Functions for Robust Control of Systems with Real Parametric Uncertainty**
Pierre Apkarian, CERT-ONERA, France; Eric Feron, Massachusetts Institute of Technology; and Pascal Gahinet, Institute National de Recherche en Informatique et Automatique, France

4:10 **H^∞ Optimal Stable Controllers**
Kathryn E. Lenz, University of Minnesota, Duluth

4:30 **Robust Semi-Global Output Regulation for Linear Systems Subject to Input Saturation**
Wei Lin, Washington University; and *Zongli Lin*, State University of New York, Stony Brook

4:50 **H^∞ Control Theory Solves an L^1 Problem**
Declan G. Bates and *Anthony M. Holohan*, Dublin City University, Ireland

5:10 **Bounds for the H_∞-Norm of a Scalar Transfer Function**
Marek Rakowski, Ohio State University

5:30 **Global Stabilization and Robustness of Linear Systems with Bounded Inputs**
Rodolfo Suarez and Jose Alvarez-Ramirez, Universidad Autonoma Metropolitana-Iztapalapa, Mexico; and Mario Sznaier, Pennsylvania State University

7:30/St. Louis Ballroom Foyer

Registration Opens

8:00-10:00

Concurrent Sessions

MS15/St. Louis D

Mechanical Systems (Part I of II)

Throughout the evolution of modern control theory, applications involving mechanical systems have provided a rich source of problems commanding the full power of the theory and occasionally pointing to new directions the theory should take. The most recent instance of a fruitful interaction between control theory and mechanics has been in the application of ideas from nonlinear control theory to problems in motion planning and control of mechanical systems featuring the complexities of nonintegrable velocity constraints and underactuation. In this minisymposium, the speakers will present recent developments in nonlinear control theory, nonholonomic mechanics, motion planning for mechanisms with nonintegrable velocity constraints, and open-loop control designs. They will discuss important applications to motion planning and control of autonomous wheeled vehicles, grasp mechanics for robot hands, and the open loop control of compressors.

Organizers: Anthony Bloch, Ohio State University and University of Michigan, Ann Arbor; John Baillieul, Boston University; and N. Harris McClamroch, University of Michigan, Ann Arbor

8:00 **Open Loop Control Designs for Compressor Dynamics**
Brad Lehman, Mississippi State University and John Baillieul, Organizer

8:30 **Geometric Mechanics and Control**
Jerrold E. Marsden, University of California, Berkeley

9:00 **Trajectory Tracking for Differentially Flat Mechanical Systems**
Richard Murray, California Institute of Technology

9:30 **Nonholonomy of Surfaces Rolling on Each Other**
Shankar Sastry, University of California, Berkeley

MS16/St. Louis B

Control of Nonlinear Distributed Parameter Systems (Part III of III)

(For description, see MS2, page 4)

Organizer: Irena M. Lasiecka
University of Virginia

8:00 **The Control of Free Boundary by Feedback Inputs**
Viorel Barbu, University of Iasi, Romania

8:30 **On Control Problems of Dispersive Wave Systems**
Bingyu Zhang, University of Minnesota, Minneapolis

9:00 **Controllability of Semilinear Hyperbolic Systems**
Daniel Tataru, Northwestern University

9:30 **Control of Systems of Partial Differential Equations Arising in Modeling of Interactive Structures**
George Avalos, University of Virginia

MS17/Directors Row 46

Differential Algebraic Formulations of Control Problems

Complex control systems are increasingly being modeled by systems of differential and algebraic equations (DAEs). Traditionally these models were converted to explicit systems. There has been increasing interest in working directly with the original implicit formulation. In this minisymposium, the speakers will provide an introduction to several interrelated aspects of this effort, including fundamental aspects of DAE control problems, optimal control problems which are naturally formulated as DAEs, and aspects of the application of numerical methods for DAEs to the predictive control of nonlinear systems.

Organizer: Stephen L. Campbell
North Carolina State University

8:00 **Index and Decomposition of Implicit Nonlinear Systems**
Michel Fliess, Laboratoire des Signaux et Systemes - C.N.R.S., France; Jean Levine, Philippe Martin, and *Pierre Rouchon*, Centre Automatiqué et Systemes, E.N.S.M.P., France

8:30 **A Direct Transcription Tool for Trajectory Optimal Control Problems**
Kathryn E. Brenan, The Aerospace Corporation

9:00 **Applications of Descriptor Predictive Control**
Ramine Nikoukhah, Dirk von Wissel and François Delebecque, Institut National de Recherche en Informatiqué et in Automatiqué, France

9:30 **On Some Application Aspects of Control Laws Based on DAE Formulations**
Krzysztof P. Jankowski, University of Windsor, Canada

MS18/St. Louis C

Parametric Uncertainty and Performance

The purpose of this minisymposium is to explore various aspects of the interplay between parametric uncertainty and system performance. These investigations were initiated by Feldbaum and Astrom in the control area, and by Davisson and Rissanen in statistics and information theory. The latter research activity led to the development of the theory of stochastic complexity. We hope to demonstrate how these two research areas can be brought into contact with each other.

Organizer: Laszlo Gerencser, Computer and Automation Institute of the Hungarian Academy of Sciences, Hungary

8:00 **Second-Order Stochastic Optimization Using Only Loss Function Measurements**
James C. Spall and C. Chin, Johns Hopkins University

8:30 **Numerical Differentiation for Parameter Estimation in Linear Stochastic Systems**
Tyrone E. Duncan, University of Kansas; Peter Mandl, Charles University, Czech Republic; and Bozenna Pasik-Duncan, University of Kansas

9:00 **Stochastic Complexity in Adaptive Control**
Laszlo Gerencser, Organizer; Jorma Rissanen, IBM, Almaden Research Center; Jan H. van Schuppen, Center for Mathematics and Informatics (CWI), The Netherlands; and Zsuzsanna Vago, Computer and Automation Institute of the Hungarian Academy of Sciences, Hungary

9:30 **The Principle of Synergy in Adaptive Control**
Istvan Valyi, University of Economics-Budapest, Hungary; and Sandor M. Veres, University of Birmingham, United Kingdom

MS19/St. Louis F

Convex Optimization in Control Theory: Algorithms and Applications

This minisymposium focuses on new developments in convex optimization and on the applications of these techniques to control problems. Recent research in the area has been strongly influenced by Nesterov and Nemirovsky's work on interior-point methods for optimization over general convex cones. The cone of positive semidefinite matrices is the most important example. The corresponding optimization problems are called semidefinite programs. They are closely related to linear programs, and unify a wide variety of convex optimization problems in control theory. The speakers in this minisymposium will address theoretical and numerical aspects, software implementation, and applications of interior-point methods for semidefinite programming.

Organizer: Lieven Vandenberghe
Katholieke Universiteit de Leuven, Belgium

8:00 **Primal-Dual Interior Point Methods for Semidefinite Programming**
Farid Alizadeh, Rutgers University; Jean-Pierre A. Haeberly, Fordham University; and *Michael L. Overton*, Courant Institute of Mathematical Sciences, New York University

8:30 **An Interior-Point Engine for Solving Structured Nonlinear Convex Programs**
Michael C. Grant, Stanford University

9:00 **Interior Point Method for Structured Semidefinite Programming**
Shinji Hara and Masakazu Kojima, Tokyo Institute of Technology, Japan; and Susumu Shindo, The National Defense Academy, Japan

9:30 **On Evaluating the Conservatism Induced by the S-procedure**
Eric M. Feron, Massachusetts Institute of Technology

8:00-10:00
Concurrent Sessions

MS20/St. Louis G
Control Applications to Finance

Because of the successes in the marketplace of the Black-Scholes option pricing methodology and mean-variance analysis, Brownian-motion-driven models of financial markets have become widely accepted both in academia and in practice. Some important practical questions can be formulated as problems in stochastic control, for example, how to hedge a position so as to minimize exposure to risk, and how to manage a portfolio so as to meet some investment objective. The speakers will discuss some of these control problems, their solutions and what we can learn from their solutions.

Organizer: Steven E. Shreve
Carnegie Mellon University

8:00 Dynamic Consumption-Portfolio Choice and Asset Pricing with Non-Price-Taking Agents
Suleyman Basak, The Wharton School, University of Pennsylvania

8:30 Nontrivial Option Hedging with Transaction Costs is Impossible
H. Mete Soner and Steven E. Shreve, Carnegie Mellon University; and *Jaksa Cvitanic*, Columbia University

9:00 Title to be announced
Mark H. A. Davis, Imperial College of Science and Technology, United Kingdom

9:30 Universal Bounds for Option Prices with Transaction Costs
Thaleia Zariphopoulou, University of Wisconsin, Madison; and George M. Constantinides, University of Chicago

MS21/St. Louis A
Aerospace Applications of Control Theory

Flight control system affordability has become the primary focus within the aerospace industry. This is of significant concern because of the trends toward multiple control effectors, more stringent performance requirements, and expanded flight envelopes all increase the time and costs to develop flight control systems. Developing new processes for designing, analyzing, simulating, and generating flight software are required to streamline the development cycle and reduce costs. Multivariable control theory, combined with automated code generation, offers the potential to significantly improve performance and reduce control system design time. The papers in this minisymposium address affordable flight control system design in four significantly different aerospace applications: the DC-X Single Stage To Orbit demonstrator, prototype fighter aircraft, high Angle of Attach agile missiles, and ejection seats.

Organizer: Kevin A. Wise
McDonnell Douglas Aerospace - East

8:00 RAPIDS Flight Control System Design for the DC-X
Ed Reil and D. Nowlan, McDonnell Douglas Aerospace - West

8:30 Affordable Control System Design for Prototype Fighter Aircraft
Larry E. Williams, Kevin A. Wise, *Joseph S. Brinker*, and James E. Buckley, McDonnell Douglas Aerospace - East

9:00 Agile Missile Control System Design Using Variable Structure Control
Rowena Eberhardt and Kevin A. Wise, McDonnell Douglas Aerospace - East

9:30 Ejection Seat Flight Control System Design Using Linear Quadratic Optimal Control
John Ritland, Mike Sharp, Joseph S. Brinker, and Kevin A. Wise, McDonnell Douglas Aerospace - East

CP7/Directors Row 25
Control and Identification of Distributed Parameter Systems I

Chair: Mary Ann Horn, University of Minnesota, Minneapolis

8:00 Constrained LQR Problems in Elliptic Distributed Boundary Control Systems with Point Observations
Puhong You and *Jianxin Zhou*, Texas A&M University, College Station

8:20 Control of a Reaction-Diffusion Problem
Tilo Staib, Universitat Erlangen-Nürnberg, Germany

8:40 Some Properties of Composed Identification-and-Control Maps
Giovanni F. Crosta, Università degli Studi di Milano, Italy

9:00 Optimality Conditions for Dirichlet Boundary Control Problems of Parabolic Type
Fausto Gozzi, Università di Pisa, Italy; and Maria Elisabetta Tessitore, Università di Roma "La Sapienza", Italy

9:20 A Method for Some Inverse Problems in Multidimensional Wave Propagations
Hua Song, University of North Carolina, Charlotte

9:40 Control of Quantum Systems
Katherine Kime, Case Western Reserve University

CP8/Directors Row 43
Optimal Control and Optimization I

Chair: U. Ledzewicz, Southern Illinois University, Edwardsville

8:00 Differences in the Second Order Necessary Conditions in Two Approaches to the Optimal Control Problem with Uncertain Data
Vladimir A. Pertsel, Weizmann Institute of Science, Israel

8:20 New Algorithms for Unconstrained Optimization Problems
Bean San Goh, University of Western Australia, Australia

8:40 Local Equivalence of Time-Optimal Control Problems to the Power Markov Moment Min-Problem
Grigoriy M. Sklyar, Kharkov State University, Ukraine

9:00 Maximum Principle for Some Optimal Control Problems with State-Dependent Control Constraints
Maria do Rosario de Pinho, Universidade do Porto, Portugal

9:20 Nontrivial Optimality Conditions in Abnormal Optimal Control Problems
U. Ledzewicz, Southern Illinois University, Edwardsville; and Heinz Schattler, Washington University

9:40 An Algorithm for Time-Optimal Control of Two-Link Manipulator
W. Szyszkowski and *R. Fotouhi-C.*, University of Saskatchewan, Canada

CP9/Directors Row 26
Adaptive Control

Chair: A.S. Poznyak, CINVESTAV-IPN, Mexico

8:00 Adaptive Control of Plants with Jumping Parameters
Warren O. Dennis and Gang Tao, University of Virginia

8:20 Information Inequalities in Adaptive Stochastic Control
A.S. Poznyak and Roberto Salas Zuñiga, CINVESTAV-IPN, Mexico

8:40 A New Robust Self-tuning Controller
Wanlin Wang and Cheng Shao, Northeastern University, People's Republic of China

9:00 Adaptive Control and Nonlinear Dynamics
Ernest Barany and Richard Colbaugh, New Mexico State University

9:20 On Self-Tuning of Continuous-Time Stochastic Adaptive Control
Karim Nassiri-Toussi and Wei Ren, University of California, Berkeley

9:40 Check of Persistent Excitation Conditions for Adaptive Control Systems
S.D. Zemlyakov, V. Yu. Rutkovsky and A.V. Silaev, Institute of Control Sciences, Russia

Friday Morning, April 28

8:00-10:00
Concurrent Sessions

CP10/Directors Row 27
H^∞ and Robust Control II

Chair: E.K. Boukas, Ecole Polytechnique de Montreal, Canada

8:00 **Robust Control of Jump Linear Systems with Uncertainties and Cost Estimation**
E.K. Boukas and H. Yang, Ecole Polytechnique de Montreal, Canada

8:20 **Stabilizing and Anti-Stabilizing Solutions of Discrete Riccati Equations with Nonpositive-Definite Weight Matrix**
Hiroyuki Kano, Tokyo Denki University, Japan

8:40 **A Robust, Continuous Sliding-mode Controller**
Wenceslao A. Cebuhar and Toby E.O. Steel, Queen's University, Canada

9:00 **On the Guaranteed Margins of Linear Quadratic Regulators**
Cishen Zhang, University of Melbourne, Australia; and *Minyue Fu*, The University of Newcastle, Australia

9:20 **Constrained H_∞ Control Design for Experimental Single Flexible Link**
Andrei Tchernychev, Jie Yu and Athanasios Sideris, University of California, Irvine

9:40 **Some Extension of the Yakubovich-Kalman Lemma**
Nikita E. Barabanov, St Petersburg State Electrical Engineering University, Russia

CP11/Directors Row 28
Control and Identification of Distributed Parameter Systems II

Chair: Giovanni F. Crosta, Università degli Studi di Milano, Italy

8:00 **Carleman Estimates and Controllability for the Heat Equation**
Daniel Tataru, Northwestern University

8:20 **Control of a Kirchhoff Plate to a Desired Profile Using Bilinear Optimal Control**
Mary E. Bradley, Massachusetts Institute of Technology, and Suzanne Lenhart, University of Tennessee, Knoxville

8:40 **A Nonlinear Control Synthesis for Regulating Fluid Flow**
Sungkwon Kang, Chosun University, South Korea

9:00 **Controllability of a Plate in an Irrotational Incompressible Fluid**
Scott Hansen, Iowa State University

9:20 **Boundary Control of Evolution Equations with Variable Coefficients**
Mary Ann Horn, University of Minnesota, Minneapolis

9:40 **Some Remarks on Controlling the Viscous Burgers' Equation**
Hung V. Ly, Kenneth D. Mease and Edriss S. Titi, University of California, Irvine

10:00/St. Louis E
Coffee

10:30/St. Louis D
IP4/Chair: Bozenna Pasik-Duncan, University of Kansas

Connecting Risk Sensitive Control Problems and Deterministic Games Through Singular Perturbations

In this presentation, the speaker will discuss a very fruitful approach to connect risk sensitive control problems and deterministic games. He will consider stochastic control problems with full and partial observation. He will also discuss connections with H^∞ control, finite horizon control, and ergodic control problems.

Alain Bensoussan
University of Paris Dauphine and INRIA, France

11:30/St. Louis D
IP5/Chair: Eric Feron, Massachusetts Institute of Technology

Convex Optimization in Control and Systems Theory

Many analysis and design problems arising in engineering can be cast, or recast, in the form of a convex optimization problem, i.e., minimizing a convex objective subject to some convex constraints. Specialized algorithms developed over the last fifteen years can solve such problems very efficiently, in theory and in practice. FIR filter design is a well known example.

Nesterov and Nemirovsky have recently extended interior-point algorithms for linear programming (such as Karmarkar's) to handle a broad class of convex problems that includes those arising in engineering. Most of the computational effort in these algorithms is the solution of a least-squares problem at each iteration. The speaker will discuss extremely efficient interior-point convex optimization algorithms for specific engineering applications. These algorithms use CG-type methods to exploit problem structure in solving these least-squares problems.

Stephen P. Boyd
Information Systems Laboratory
Stanford University

12:30
Lunch

Friday Afternoon, April 28

2:00/St. Louis D
IP6/Chair: Steven E. Shreve, Carnegie Mellon University

Viscosity Solutions and Their Applications

The method of dynamic programming provides a powerful tool for studying deterministic and stochastic optimal control problems. The main object of analysis is the value function which formally solves a nonlinear equation. However it is well known that in most cases, the value function is not smooth enough to satisfy this equation in a classical sense. Therefore a weak formulation of solutions is necessary. In their celebrated 1984 paper, Crandall and Lions provided such a weak formulation which they called viscosity solutions and characterized the value function of deterministic problems as the unique viscosity solution. Since then, elegant reformulations were obtained by Crandall, Evans and Lions and Jensen proved the uniqueness of viscosity solutions to second order equations (control of diffusion processes).

In this presentation, the speaker will give an introduction to viscosity solutions and discuss applications to several control problems, including the heavy traffic analysis of a queueing system with multi-class customers, option pricing with transaction costs, convergence analysis of numerical schemes, risk sensitive control and phase transitions and front propagation.

H. Mete Soner
Department of Mathematics
Carnegie Mellon University

3:00/St. Louis E
Coffee

3:30-5:30
Concurrent Sessions

MS22/St. Louis D
Mechanical Systems (Part II of II)

(For description, see MS15, Page 9)

Organizers: Anthony M. Bloch, Ohio State University and University of Michigan, Ann Arbor; John Baillieul, Boston University; and N. Harris McClamroch, University of Michigan, Ann Arbor

3:30 **Tracking in Nonholonomic Dynamic Systems via Sliding Modes**
Sergey Drakunov, Ohio State University and Anthony M. Bloch, Organizer

4:00 **Explicit Stabilization of a Class of Flat Nonholonomic Systems**
Michelle Fliess, CNRS-ESE, France

4:30 **Optimal Control, Mechanics and Geometry**
V. Jurdjevich, University of Toronto, Canada

5:00 **Open Loop Control using Periodic Excitation**
Danbing Seto and Roger Brockett, Harvard University

MS23/Rose Garden Room
Nonstandard Riccati Equations Arising in Boundary Control Problems

Recent research activities in the area of systems and control have resulted in theories that center on certain Riccati-type equations of non-traditional or non-standard type. Standard algebraic Riccati equations are those arising in connection with optimal quadratic (definite) cost problems for a linear dynamics over an infinite horizon, the heart of control theory since its origin. Non-standard equations arise from such diverse areas as: min-max game theory problems with quadratic "non-definite" cost, H_∞ theory, with complete or partial observation; optimal quadratic (definite) cost for certain boundary control problems for second order equations and with high damping and control action in a suitable "bad" boundary condition; the study of algebraic Riccati equations and corresponding inequalities. The speakers will address all of the above problems, with emphasis on partial differential equations where the control, and possibly the disturbance, act on the boundary.

Organizer: Roberto Triggiani
University of Virginia

3:30 **Singular Regulator Problem for a System Governed by a Parabolic Equation**
Luciano Pandolfi, Politecnico di Torino, Italy

4:00 **Min-Max Game Theory for Partial Differential Equations**
Christine McMillan, Massachusetts Institute of Technology

4:30 **Riccati Equations vs. Riccati Inequalities: A Subspace Approach**
Leiba Rodman, The College of William and Mary

5:00 **Control of Wave Generators in a Canal by H^∞ Theory**
Jean Pierre Yvon, Université de Technologie, Compiegne, France

MS24/St. Louis A
Optimal Control and Nonlinear Controllability (Part I of II)

This minisymposium is devoted to the topics of optimal control theory and nonlinear controllability of systems governed by ordinary differential equations. The speakers will address these topics from various points of view, including the geometric approach and the nonsmooth analysis approach. They will also present recent applications in nonlinear design, numerical and computational methods, and the calculus of variations.

Organizer: Kevin A. Grasse
University of Oklahoma

3:30 **Numerical Methods in Optimal Control**
William Hager, University of Florida, Gainesville

4:00 **Nonsmooth Analysis and Optimization in Nonlinear Control**
Boris Mordukhovich, Wayne State University

4:30 **Open Mapping Theorems, Semidifferentiable Maps, and A Very Nonsmooth Version of the Maximum Principle of Optimal Control Theory**
Hector J. Sussmann, Rutgers University

5:00 **Discussion**

MS25/St. Louis B
Control-Theoretic Applications of Convex Optimization

(This session will run until 6:00 PM).

Convex optimization has emerged over the past few years as one of the most important mathematical tools available to control engineers. Indeed, convex optimization has proved useful results of control theory to handle more realistic situations, such as multi-objective controller design and sophisticated robustness problems. The speakers in this minisymposium will present new applications of convex optimization to control theory, with a particular emphasis on robustness and robust performance issues.

Organizer: Eric M. Feron
Massachusetts Institute of Technology

3:30 **Spectral Analysis of Uncertain Systems**
Anders Rantzer, Lund Institute of Technology, Sweden; and Alexandre Megretski, Iowa State University

4:00 **Analysis of Systems with Bounded Uncertain Delays**
Alexandre Megretski, Iowa State University; and Anders Rantzer, Lund Institute of Technology, Sweden

4:30 **On Computing Bounds on the Worst-Case H_2 Norm of Parameter-Dependent Linear Systems**
V. Balakrishnan, Purdue University, West Lafayette

5:00 **Robustness Under Bounded Uncertainty with Phase Formation**
Andre L. Tits, University of Maryland, College Park; Li Lee, National Sun Yat-Sen University, Taiwan; and V. Balakrishnan, Purdue University, West Lafayette

5:30 **LMI Solution to Coupled Riccati Equations Arising for Jump Linear Systems**
Laurent El Ghaoui and Mustapha Ait-Rami, Ecolé Nationale Superieure de Techniqués Avanceés, France

MS26/St. Louis C
Nonlinear H^∞ Control and Viscosity Solutions

(This session will run until 6:00 PM).

H^∞ control for linear systems has proven to be a highly useful approach for many problems. Recently, a state-space formulation of the H^∞ problem has been obtained via differential games (and/or dissipative systems). The state-space formulation has allowed an extension of the theory to nonlinear systems. Dynamic programming may be used to reduce the problem to that of solution of a first-order PDE (or inequality). This equation (or inequality) and its connection to H^∞ control have been undergoing intense study. Since the solutions are not smooth even under restrictive assumptions, the method of viscosity solutions appears to be a promising approach. The speakers in this minisymposium will address both theoretical and practical questions regarding nonlinear H^∞ control.

Organizer: William M. McEneaney
Carnegie-Mellon University

3:30 **Viscosity Solutions of Hamilton-Jacobi Equations Arising in Nonlinear H^∞ Control**
Joseph A. Ball, Virginia Polytechnic Institute and State University; and J. William Helton, University of California, San Diego

4:00 **The Risk-Sensitive Index and the H-2 and H^∞ Norms for Nonlinear Systems**
Wendell H. Fleming, Brown University; and M.R. James, Australian National University, Australia

4:30 **Some Computational Issues in Nonlinear H^∞ Control**
M.R. James, Australian National University

5:00 **Necessary and Sufficient Conditions for Nonlinear Worst Case (H^∞) Control and Estimation**
Arthur J. Krener, University of California, Davis

5:30 **Aerospace Plane Application of Nonlinear Robust Control**
William M. McEneaney, Organizer and K.D. Mease, University of California, Irvine

3:30-5:30
Concurrent Sessions

MS27/St. Louis F
Stochastic Theory-Adaptive Control (Part I of II)

(This session will run until 6:00 PM).

In this minisymposium, some leading researchers on stochastic control and stochastic adaptive control will present some very recent theoretical and computational results in stochastic control and stochastic adaptive control with some very interesting applications. They will discuss some interesting models. They will show how beautifully stochastic theory can be applied to many problems of the kind presented here.

Organizer: Bozenna J. Pasik-Duncan
University of Kansas

3:30 Adaptive Control of General Ergodic Markov Processes: Bayesian versus Parametric Approach
Lukasz Stettner, Polish Academy of Sciences, Poland

4:00 Bayesian Identification of Markov Processes with Unknown Generators
Raymond Rishel, University of Kentucky

4:30 Risk-Sensitive Optimal Control of Hidden Markov Models
Steven Marcus, University of Maryland, College Park

5:00 Controlling Interest Rates to Minimize Inflation
Ulrich Haussmann and Maria Chiarolla, University of British Columbia, Canada

5:30 On Duality Between Risk Sensitive Control and Dynamic Games
P. Dai Pra, L. Meneghini, and *W.J. Runggaldier*, Università di Padova, Italy

MS28/St. Louis G
Chemical Process Control

The speakers in this minisymposium will address a broad range of problems and methodologies related to chemical process control; they will present an overview of current research activity, and discuss open problems of theoretical interest. Specifically, they will focus on the control of industrial film and sheet forming processes modeled by linear discrete-time stochastic systems, the modeling and analysis of combined continuous and discrete processes, the design of state observers for nonlinear processes and the development of control methodologies for processes modeled by coupled differential and algebraic equations.

Organizer: Prodromos Daoutidis
University of Minnesota, Minneapolis

3:30 Gage Control of Film and Sheet Forming Processes
John C. Campbell and *James B. Rawlings*, University of Texas, Austin

4:00 A Class of 'Linear' Hybrid Event Models for Process Applications
Jeffrey C. Kantor, University of Notre Dame

4:30 A State Reconstruction Method for Nonlinear Systems
Costas Kravaris and Nikos Kazantzis, University of Michigan, Ann Arbor

5:00 Control of High-Index Differential-Algebraic-Equation Systems
Aditya Kumar, University of Minnesota, Minneapolis and *Prodromos Daoutidis*, Organizer

CP12/Directors Row 43
Optimal Control and Optimization II

Chair: Kurt S. Riedel, Courant Institute of Mathematical Sciences, New York University

3:30 Synthesis of Dynamic Feedback Controllers for Uncertain Linear Systems by Convex Optimization
William R. Colmenares, Universidad Simon Bolivar, Venezuela; Jacques Bernussou and Germain Garcia, Laboratoire d'Automatique et d'Analyse des Systemes, France

3:50 New Results in L^∞ Control
E.N. Barron, Loyola University

4:10 Generalized Legendre-Clebsch Necessary
Bean San Goh, University of Western Australia, Australia

4:30 An Application of Catastrophe Theory to Control
Gwen L. Tanner, Defence Research Agency, United Kingdom

4:50 Piecewise Convex Function Estimation: Duality, Fast Optimization, Model Selection
Kurt S. Riedel, Courant Institute of Mathematical Sciences, New York University

5:10 Restricted Simplicial Decomposition with Side Constraints and Its Applications to Capacitated Traffic Assignment Problems
Chih-Hang Wu, Kansas State University, Manhattan; and José A. Ventura, Pennsylvania State University

CP13/Directors Row 46
Nonlinear Systems and Control II

Chair: Clyde Martin, Texas Tech University

3:30 Deterministic Singularly Perturbed Control Systems: Statistical Limiting Behavior Governed by Associated Invariant Measures
Alexander Vigodner, Weizmann Institute of Science, Israel

3:50 Control of Muscular Contraction Through Spinal Reflexes
Clyde Martin and *Lawrence Schovanec*, Texas Tech University; and Robert Yost, Texas Tech University Health Sciences Center

4:10 Index of Differential Algebraic Equations and Formal Integrability
Georges Le Vey, Ecole des Mines, France; O.P. Piirila and J. Tuomela, Helsinki University of Technology, Finland

4:30 Approximation Capabilities of Quaternion-Valued Neural Networks
P. Arena, Luigi Fortuna, R. Re and M.G. Xibilia, Università di Catania, Italy

4:50 Improving the Efficiency of the Classical Cell-to-Cell Mapping
Salvatore Baglio, Luigi Fortuna and Giovanni Muscato, Università di Catania, Italy

5:10 Positive Orthant Controllability of Bilinear Systems
Yuri L. Sachkov, Program Systems Institute RAS, Russia

5:30 The Invariance Properties of the Blackmore's Swept Dynamical Systems in R^3
Anatoliy K. Prikarpatsky, Institute for Applied Problems of Mechanical Mathematics, Ukraine; Denis Blackmore, New Jersey Institute of Technology; and Roman Samuliak, Lviv Politechnical University, Ukraine

CP14/Directors Row 26
Systems Theory and Applications

Chair: Diane Mathios, San Jose City College

3:30 Statistical Quality Control: A Data Assessment System Used with Cooperative Learning in a University Summer Bridge Program
Diane Mathios, San Jose City College; and *Charles B. Pierre*, Clark Atlanta University

3:50 Lower Bounds on the Gap Metric
Arthur M.J. Kyle, NASA/Goddard Space Flight Center; and Guy O. Beale, George Mason University

4:10 A Multiple Paradigm Approach in Knowledge-Based Simulation Program Development
James J. Tarng and Kevin D. Reilly, University of Alabama, Birmingham

4:30 On Upper Bounds of the Structured Singular Value
Minyue Fu, The University of Newcastle, Australia

4:50 The Two Inverse Eigenvalue Problems for Jacobi Matrices
Da-Wei Chang, Shaanxi Normal University, People's Republic of China

5:10 Invariant Systems Design by the Decomposition Method
Victor A. Utkin, Institute of Control Sciences, Russia

CP15/Directors Row 27
Computational and Numerical Methods in Control and Optimization I

Chair: Dan Tiba, Institute of Mathematics, Romanian Academy, Romania

3:30 Using Randomization to Break the Curse of Dimensionality
John Rust, University of Wisconsin, Madison

3:50 Active Control of 3D Broad-Band Noise
Richard H. Burkhart, Boeing Computer Services

4:10 On the Approximation of Some Ill Posed Problems
P. Neittaanmaki and T. Raisanen, University of Jyvaskyla, Finland; and *Dan Tiba*, Institute of Mathematics, Romanian Academy, Romania

3:30-5:30
Concurrent Sessions

4:30 **Multigrid Methods for Optimization Problems Governed by Elliptic PDEs**
Eyal Arian and Shlomo Ta'asan, ICASE, NASA Langley Research Center

4:50 **Twofold Spline Approximation Scheme for the LQG Control Problem of General Hereditary Systems**
Alfredo Germani, C. Manes and P. Pepe, Università degli Studi di L'Aquila, Italy; and L. Jetto, Università degli Studi di Ancona, Italy

5:10 **Roundoff Error Analysis of Algorithms for the Multiple-Input State Feedback Pole Assignment Problem**
Mark E. Cawood and Christopher L. Cox, Clemson University

5:30 **Trajectory Optimization by Direct Interior Point SQP Methods**
Marc C. Steinbach, Universität Heidelberg, Germany

CP16/Directors Row 28
Feedback Systems and Feedback Control

Chair: Jesus Leyva-Ramos, Universidad Autonoma de San Luis Potosi, Mexico

3:30 **Positive Real and Bounded Real Lemmas for Singularly Perturbed Systems with Application to Model Reduction**
Hossein M. Oloomi, Purdue University, Ft. Wayne

3:50 **PI-Controller Design for High Frequency Switching Regulators**
Jesus Leyva-Ramos and Jorge Alberto Morales-Saldana, Universidad Autonoma de San Luis Potosi, Mexico

4:10 **When is a Kalman Filter Less Preferable in State Feedback Control Applications**
Chia-Chi Tsui, Staten Island, NY

4:30 **Reference Model Controller with Evading from Moving Interceptor**
Yuzo Yamane, Ashikaga Institute of Technology, Japan

4:50 **The Problem of Observation of Objects with Hidden Intrinsic States (HISO)**
Alexander N. Shoshitaishvili, Institute of Control Sciences, Russia

St. Louis E
Poster Session

An Iterative Procedure for Computing Approximate Solutions to H^2/H^∞ Problems
Gilberto O. Correa, D.M. Sales, and T.M. Soares, LNCC/CNP1, Brazil

Improving Reliability of Field Oriented Control Induction Motor Drives
E.E. El-Kholy, Menoufiya University, Egypt and Centre de Recherche en Automatique de Nancy, France; M. Abdel-Karim and S.A. Mahmoud, Menoufiya University, Egypt; and C. Iung, Centre de Recherche en Automatique de Nancy, France

On the Transient Performance of Self-tuning Controller with Input Constraint
Wen Yu and Tianyou Chai, Northeastern University, People's Republic of China

Adaptive Output Stabilization for a Class of Mechanical Systems
Richard Colbaugh and E. Barany, New Mexico State University

Properties of a Nonlinear Delay-Differential Equation for an Age-Structured Population
Sanjay Rai, Texas A&M International University; and *Dennis W. Brewer*, University of Arkansas, Fayetteville

On the Topologies of Spaces of Linear Dynamical Systems Commonly Employed as Models for Adaptive and Robust Control Design
Felipe M. Pait, Universidade de Sao Paulo, Brasil

Convex Optimization for Controller Design
J. Andrew Donnellan and *Anthony M. Holohan*, Dublin City University, Ireland

Implementable Bounds for a Neural Networks Algorithm in Communication Traffic Control
Alexandru Murgu and *Pekka Neittaanmaki*, University of Jyvaskyla, Finland

Stability of Linear Repetitive Processes — A Numerical Range Interpretation
Eric Rogers, University of Southampton, United Kingdom; and David H. Owens, University of Exeter, United Kingdom

Computational Aspects of Stochastic Systems
Tracy Atteberry, Zhishang Chen, Mark Frei, Ai-Jun Gao, Shane Hass, Suk Hyung Lee, Zennong Wang, Nathan Welch and *Omar Zane*, University of Kansas

Discrete-Time Markovian Jump Linear Systems
Krzysztof Szajowski, Technical University of Wroclaw, Poland; and W.L. de Koning, Delft University of Technology, The Netherlands

6:00/St. Louis A
Business Meeting
SIAM Activity Group on Control and Systems Theory

Studies in Applied Mathematics 15

Linear Matrix Inequalities in System and Control Theory

Stephen Boyd, Laurent El Ghaoui, Eric Feron, and Venkataramanan Balakrishnan

In this book the authors reduce a wide variety of problems arising in system and control theory to a handful of convex and quasiconvex optimization problems that involve linear matrix inequalities. These optimization problems can be solved using recently developed numerical algorithms that not only are polynomial-time but also work very well in practice; the reduction therefore can be considered a solution to the original problems. This book opens up an important new research area in which convex optimization is combined with system and control theory, resulting in the solution of a large number of previously unsolved problems.

Special Features

- The book identifies a handful of standard optimization problems that are general (a wide variety of problems from system and control theory can be reduced to them) as well as specific (specialized numerical algorithms can be devised for them).
- The book catalogs a diverse list of problems in system and control theory that can be reduced to the standard optimization problems. Problems considered are analysis and state-feedback design for uncertain systems, matrix analysis problems, and many others.
- Most of the the book is accessible to anyone with a basic mathematics background, e.g., linear algebra and differential equations.

Partial Contents

Royalties from the sale of this book are contributed to the SIAM Student Travel Fund.

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Thursday Morning, April 27

7:00 — **Registration opens**
St. Louis Ballroom Foyer

7:30

7:45 — **Opening Remarks and Announcements**
John E. Lagnese
St. Louis D

8:00 — **IP1** **Dynamical Systems and Their Associated Automata**
Roger W. Brockett
St. Louis D

9:00 — **IP2** **Why is Controlling High-Speed Networks a Challenge?**
Hans T. Kung
St. Louis D

10:00 — **Coffee**
St. Louis E

10:30 — **Concurrent Sessions**

MS1 **Motion Planning I: Optimal Control**
Organizers: John Baillieul, Anthony Bloch and Peter Crouch
St. Louis D

MS2 **Control of Nonlinear Distributed Parameter Systems I**
Organizer: Irena Lasiecka
Rose Garden Room

MS3 **Control Theory and Medicine**
Organizer: Clyde Martin
St. Louis A

MS4 **Diffusion Approximations of Control Queueing Theory**
Organizers: L. Felipe Martins and H. Mete Soner
St. Louis B

MS5 **Optimal Control of Fluids and Heat Conduction**

Friday Morning, April 28

Registration opens
St. Louis Ballroom Foyer

Concurrent Sessions

MS15 **Mechanical Systems I**
Organizers: John Baillieul, Anthony Bloch and N. Harris McClamroch
St. Louis D

M16 **Control and Nonlinear Distributed Parameter Systems III**
Organizer: Irena Lasiecka
St. Louis B

MS17 **Differential Algebraic Formulations of Control Problems**
Organizer: Stephen L. Campbell
Directors Row 46

MS18 **Parametric Uncertainty and Performance**
Organizer: Laszlo Gerencser
St. Louis C

MS19 **Convex Optimization in Control Theory: Algorithms and Applications**
Organizer: Lieven Vandenberghe
St. Louis F

MS20 **Control Applications to Finance**
Organizer: Steven E. Shreve
St. Louis G

MS21 **Aerospace Applications of Control Theory**
Organizer: Kevin A. Wise
St. Louis A

CP7 **Control and Identification of Distributed Parameter Systems I**
Directors Row 25

CP8 **Optimal Control and Optimization I**
Directors Row 43

CP9 **Adaptive Control**
Directors Row 26

CP10 **H^∞ and Robust Control II**
Directors Row 27

CP11 **Control and Identification of Distributed Parameter Systems II**
Directors Row 28

Coffee
St. Louis E

IP 4 **Connecting Risk Sensitive Control Problems and Deterministic Games Through Singular Perturbations**
Alain Bensoussan
St. Louis D

Saturday Morning, April 29

Registration opens
St. Louis Ballroom Foyer

Concurrent Sessions

MS29 **Applications of PDE Control Methods I**
Organizers: H.T. Banks and John A. Burns
St. Louis D

MS30 **Numerical Problems in Control Theory *(This session will run until 10:30 AM)***
Organizer: William Hager
Rose Garden Room

MS31 **Singular Perturbations of Controlled Markov Processes and Applications**
Organizer: Jerzy Filar
St. Louis A

MS32 **Sliding Mode Control of Large Scale Systems**
Organizers: Sergey Drakunov and Yuri Shtessel
St. Louis B

MS33 **Applications of Control Theory to Economic Theory**
Organizers: Mohamed El-Hodiri and Fred Van Vleck
St. Louis C

MS34 **Modeling and Control for Hybrid Systems I**
Organizers: Jing Sun and Kenneth Butts
St. Louis F

MS35 **Combinatorial Methods in Nonlinear Control**
(This session will run until 10:30 AM)
Organizer: Matthias Kawski
St. Louis G

CP17 **Computational and Numerical Issues in Control and Optimization II**
Directors Row 46

CP18 **Control and Identification of Distributed Parameter Systems III**
Directors Row 43

CP19 **Industrial and Aerospace Applications I**
Directors Row 26

CP20 **Stabilization and Robustness of Linear Systems**
Directors Row 27

Coffee
St. Louis E

IP7 **Control of Nonlinear Partial Differential Equations with Applications to Fluid Dynamics**
John A. Burns
St. Louis D

11:30

MS6 **Recent Advances in Control and Optimization of Manufacturing Systems I**
Organizers: George Yin and Qing Zhang
St. Louis F

MS7 **Advances in Computational Methods for Control and Systems I** *(This session will run until 1:00 PM)*
Organizer: Biswa Datta
St. Louis G

CP1 **Stochastic Systems**
Directors Row 46

CP2 **Stability and Robustness of Nonlinear Systems**
Directors Row 43

CP3 **Delay Systems and Hybrid Systems**
Directors Row 26

IP5 **Convex Optimization in Control and Systems Theory**
Stephen P. Boyd
St. Louis D

IP8 **State-Space and I/O Stabilization for Nonlinear Systems**
Eduardo Sontag
St. Louis D

Thursday Afternoon, April 27

12:30 **Lunch**

2:00

IP3 **Symmetry, Heteroclinic Cycles, Noise and Control**
Philip Holmes
St. Louis D

3:00 **Coffee**
St. Louis E

3:30

Concurrent Sessions

MS8 **Motion Planning II: Nonholonomic Mechanics**
Organizers: John Baillieul, Anthony Bloch, and N. Harris McClamroch
St. Louis D

MS9 **Control of Nonlinear Distributed Parameter Systems II**
Organizer: Irena Lasiecka
Rose Garden Room

MS10 **Singular Perturbations in Control: Recent Developments** *(This session will run until 6:00 PM)*
Organizer: Vladimir Gaitsgory
St. Louis A

MS11 **Numerical Methods in Stochastic Control**
Organizer: Paul Dupuis
St. Louis B

MS12 **Control of Unsteady, Viscous Incompressible Flows**
Organizer: L. Steven Hou
St. Louis C

MS13 **Recent Advances in Control and Optimization of Manufacturing Systems II**
Organizers: George Yin and Qing Zhang
St. Louis F

MS14 **Advances in Computational Methods for Control and Systems II** *(This session will run until 6:30 PM)*
Organizer: Biswa Datta
St. Louis G

CP4 **Linear Systems**
Directors Row 46

CP5 **Nonlinear Systems and Control I**
Directors Row 43

CP6 **H^∞ and Robust Control I**
Directors Row 26

5:30

6:00

Wednesday Evening, April 26

6:00-8:00 Registration opens
St. Louis Ballroom Foyer

6:00-8:00 Welcoming Reception
Rose Garden Room

Friday Afternoon, April 28

Lunch

IP6 **Viscosity Solutions and Their Applications**
H. Mete Soner
St. Louis D

Coffee
St. Louis E

Concurrent Sessions

MS22 **Mechanical Systems II**
Organizers: John Baillieul, Anthony Bloch, and N. Harris McClamroch
St. Louis D

MS23 **Nonstandard Riccati Equations Arising in Boundary Control Problems**
Organizer: Roberto Triggiani
Rose Garden Room

MS24 **Optimal Control and Nonlinear Controllability I**
Organizer: Kevin Grasse
St. Louis A

MS25 **Control-Theoretic Applications of Convex Optimization** *(This session will run until 6:00 PM)*
Organizer: Eric Feron
St. Louis B

MS26 **Nonlinear H^∞ Control and Viscosity Solutions** *(This session will run until 6:00 PM)*
Organizer: William McEneaney
St. Louis C

MS27 **Stochastic Theory - Adaptive Control I** *(This session will run until 6:00 PM)*
Organizer: Bozenna Pasik-Duncan
St. Louis F

MS28 **Chemical Process Control**
Organizer: Prodromos Daoutidis
St. Louis G

CP12 **Optimal Control and Optimization II**
Directors Row 43

CP13 **Nonlinear Systems and Control II**
Directors Row 46

CP14 **Systems Theory and Applications**
Directors Row 26

CP15 **Computational and Numerical Methods in Control and Optimization I**
Directors Row 27

CP16 **Feedback Systems and Feedback Control**
Directors Row 28

Poster Session
St. Louis E

6:00 **Business Meeting**
SIAM Activity Group on Control and Systems Theory
St. Louis A

Saturday Afternoon, April 29

Lunch

IP9 **Inverse Problems for Semilinear Elliptic Equations**
Michael Vogelius
St. Louis D

Coffee
St. Louis E

Concurrent Sessions

MS36 **Applications of PDE Control Methods II**
Organizers: H.T. Banks and John A. Burns
St. Louis D

MS37 **Optimal Control and Nonlinear Controllability II**
Organizer: Kevin Grasse
Rose Garden Room

MS38 **Nonsmooth Methods in Optimal Control**
Organizers: Helena Frankowska and R.B. Vinter
St. Louis A

MS39 **Stochastic Theory - Adaptive Control II**
Organizer: Bozenna Pasik-Duncan
St. Louis B

MS40 **Modeling and Control for Hybrid Systems II**
Organizers: Jin Sun and Kenneth Butts
St. Louis C

CP21 **Fuzzy Systems and Intelligent Control**
Directors Row 43

CP22 **Industrial and Areospace Applications II**
Directors Row 46

CP23 **Stochastic Control, Filtering and Estimation**
Directors Row 26

Farewell Reception
The reception will be held from 5:30– 7:00 in the Rose Garden Room

Times allowed for each presentation, including questions and answers:

20 minutes for a contributed presentation (CP)
30 minutes for a minisymposium presentation (MS)
60 minutes for a plenary presentation (IP)

The Conference Organizing Committee expects every speaker of a scheduled presentation to register and attend the conference. If it becomes inevitable for a speaker to cancel the presentation, the speaker is expected to find an alternate presenter or one of the speaker's co-authors should give the presentation.

A canceled presentation can cause serious inconvenience to the audience and the conference organizers.

Saturday Morning, April 29

7:30/St. Louis Ballroom Foyer

Registration Opens

8:00-10:00

Concurrent Sessions

MS29/St. Louis D

Applications of PDE Control Methods (Part I of II)

During the past 20 years there has been tremendous progress in the development of theoretical control methods for systems governed by PDE's. More recently, interest in actually using these methods in specific problems at government laboratories and in industry has exhibited strong growth. In Part I of this minisymposium, the speakers are young researchers involved in such projects. All are recent Ph.D.'s (last 5 years) who are currently involved in serious efforts on the applications of theoretical PDE control methods to develop models and computational algorithms in applied projects.

Organizers: H.T. Banks, North Carolina State University; and John A. Burns, Virginia Polytechnic Institute and State University

8:00 **Localization of Electromagnetic Energy**
Yun Wang, Armstrong Laboratory, Brooks AFB

8:30 **Active Control of Coupled Torsion and Bending**
Christian A. Smith and E. H. Anderson, CSA Engineering, Palo Alto

9:00 **Distributed Parameter Control Techniques for Structural Acoustic Systems**
Ralph C. Smith, Iowa State University

9:30 **Robustness Results on the MinMax-Tracking Control in Structural Acoustic Models**
Michael A. Demetriou, North Carolina State University

MS30/Rose Garden Room

Numerical Problems in Control Theory

(This session will run until 10:30 AM).

Optimal control problems provide a formidable challenge for researchers trying to develop a rigorous understanding of errors and convergence analysis for numerical methods. A problem may be differentiable in one norm, coercive in another norm, while yet another norm comes into play in complementarity conditions. Recently, there has been much progress in the development of a mathematical framework for analyzing the errors resulting from discretizations of continuous problems and in the analysis of the convergence of algorithms. This minisymposium focuses on some of the important advances in the numerical analysis of optimal control problems.

Organizer: William W. Hager
University of Florida, Gainesville

8:00 **A Priori Estimates for Discrete Approximations in Nonlinear Optimal Control**
Asen Dontchev, Mathematical Reviews, Ann Arbor

8:30 **On the Pontryagin Minimum Principle and Iterative Algorithms for Optimal Control Problems**
Joseph Dunn, North Carolina State University

9:00 **Finite Element Approximations of Compensator Designs Arising in Hyperbolic Structures**
Irena M. Lasiecka, University of Virginia

9:30 **Computational Sensitivity Analysis for Parametric Control Problems**
Helmut Mauer, Universität Munster, Germany

10:00 **Consistent Approximations for Optimal Control Problems Based on Runge-Kutta Integration**
E. Polak, University of California, Berkeley

MS31/St. Louis A

Singular Perturbations of Controlled Markov Processes and Applications

Singularly perturbed, controlled Markov chains and general Markov processes are two classes of dynamical systems characterized by *coexistence* of various time scales. The speakers in this minisymposium will discuss the use of asymptotic methods in the analysis of the limit (when perturbation goes to zero), *hybrid* systems as a bridge linking the theory of singularly perturbed deterministic dynamical systems with that of perturbed Markov chains, *aggregation methods* to obtain an equivalent of the *limit control principle,* and *approximation methods, long-run frequency space analysis for Markov chains,* and *aggregation-disaggregation techniques,* to obtain algorithmic results. They will also consider applications in the area of flexible manufacturing systems.

Organizer: Jerzy A. Filar
University of South Australia, Australia

8:00 **Ergodic Control of Singularly Perturbed Markov Processes in Discrete Time with General State and Compact Action Spaces**
Tomasz Bielecki, University of Illinois, Chicago and L. Stettner, Polish Academy of Sciences, Poland

8:30 **Control of Hybrid (Differential-Stochastic) System with Fast Stochastic Part**
Eitan Altman, INRIA, France and Vladimir Gaitsgory, University of South Australia, Australia

9:00 **Singular Perturbation Methods for Manufacturing Flow Control**
A. Haurie, Universite de Geneve, Switzerland; Jerzy A. Filar, Organizer; and J-P. Vial, Universite de Geneve, Switzerland

9:30 **Aggregation-Disaggregation Algorithms for Nearly Decomposable Markov Control Problems**
A. Abbad, Faculte des Sciences de Rabat, Morocco

MS32/St. Louis B

Sliding Mode Control of Large Scale Systems

Sliding Mode Control is a very powerful nonlinear control technique with many applications. In cases where classical control methods are not applicable due to the strong nonlinearity and uncertainty of the problem, it has proved to be an effective tool for rejecting disturbances and parameter variations. This is especially important in applications to large-scale systems where due to complexity the normal operational mode is a failure mode.

The speakers will discuss the directions of future development from the standpoint of large scale systems. They will cover several topics in sliding mode control theory and its applications, including variable structures and sliding modes in decentralized nonlinear control, hybrid and intelligent systems, output control, and tracking.

Organizers: Sergey Drakunov, The Ohio State University, Columbus; and Yuri B. Shtessel, University of Alabama, Huntsville

8:00 **Multiresolutional Variable Structure Controller**
Alexander M. Meystel, Drexel University

8:30 **Decentralized Sliding Mode Control of Large Scale Systems**
Dragoslav D. Siljak, Santa Clara University and Sergey V. Drakunov, Organizer

9:00 **Dynamic Sliding Mode Control Strategy in Systems of Inertial Navigation**
Yuri B. Shtessel, Organizer

9:30 **Sliding Mode Control via Lyapunov Approach in Nonlinear Large Scale Systems**
Raymond DeCarlo, Purdue University, West Lafayette and *Sergey V. Drakunov,* Organizer

MS33/St. Louis C

Applications of Control Theory to Economic Theory

In this minisymposium, the speakers will present applications of results from optimal control theory to related areas of dynamic economic theory. They will discuss applications to landfill capacity constraints and human capital taxation, consumer discount rates, and existence of balanced growth equilibrium. The common theme is the study of individual optimizing behavior over time, with attention to the influence of exogenous parameters. They will discuss the use of existence and characterization results from optimal control theory with bounded state variables and explore the social implications of proposed policies.

Organizers: Mohamed El-Hodiri and Fred Van Vleck, University of Kansas

8:00 **Taxing Human Capital**
Mohamed El-Hodiri, Organizer

8:00-10:00

Concurrent Sessions

8:30 **Municipal Recycling and Landfill Capacity Constraint**
Jannet Highfill and Michael McAsey, Bradley University

9:00 **Consumption Over Time and the Rate of Time Preference**
William Weber, Eastern Illinois University

9:30 **The Existence of a Balanced Growth Equilibrium**
Jianbo Zhang, University of Kansas

MS34/St. Louis F

Modeling and Control for Hybrid Systems (Part I of II)

Hybrid systems refer to the systems whose dynamics and requirements are described by differential (or difference) equations and finite state automata. Because most sophisticated control systems can be modeled as hybrid systems, the issues of modeling and control for hybrid systems have become increasingly interesting. Recent research activities in this area have concentrated on defining a seamless framework for analysis, design and implementation of hybrid systems. The speakers will provide a coherent overview of recent progress and research directions covering several aspects of hybrid control systems, including modeling, requirements specification, control design and analysis, design tools, and industrial applications.

Organizers: Jing Sun and Kenneth R. Butts
Ford Research Laboratory

8:00 **Distributed Hybrid Autonomous Control**
Anil Nerode, Cornell University and Wolf Kohn, Intermetrics, Bellevue, Washington

8:30 **Declarative Hybrid Control Architecture: A Schema for Intelligent Control**
Wolf Kohn, Intermetrics, Bellevue, Washington

9:00 **Title to be announced**
Henry Sipma and Zohor Manna, Stanford University

MS35/St. Louis G

Combinatorial Methods in Nonlinear Control

(This session will run until 10:30 AM).

The step from linear to nonlinear control systems has forced the development of new analytical tools, in which various series expansions play a most prominent role. Some of these tools have been adapted from other mathematical domains, others originated in the analysis of controlled dynamical systems.

The speakers in this minisymposium will survey a selection of new tools and recent developments, e.g. exponential product expansions of Lie series, and connections between Volterra series and chronological algebras, complement the dynamical systems point of view with an algebraic combinatorics perspective and using an application to numerical analysis problems, demonstrate that the utility of the new tools and methods extends far beyond the control context.

Organizer: Matthias Kawski
Arizona State University

8:00 **On the Numerical Integration of Time Dependent Systems**
Peter E. Crouch and Yan Yan, Arizona State University; and R. Grossman, University of Illinios, Chicago

8:30 **Combinatorial Algorithms and Bases of Free Lie Algebras - Are Lyndon Words Better?**
Guy de Melancon, University of Bordeaux, France

9:00 **Volterra Series and Combinatorics of Permutations**
Andrei A. Agrachev, Steklov Mathematical Institute, Russia

9:30 **Toward A Combinatorial Interpretation of the Lyapunov Exponents**
Francoise Lamnabhi-Lagarrigue, CNRS Ecole Superieure d'Electricite, France

10:00 **Chronological Products: Combinatorics and Control**
Matthias Kawski, Organizer

CP17/Directors Row 46

Computational and Numerical Issues in Control and Optimization II

Chair: Edyta Jacewicz, University of Lodz, Poland

8:00 **Optimal Control, Sequential Analysis and Bayesian Experiment Design**
Mark H.A. Davis and *Mohammad Farid*, Imperial College, United Kingdom

8:20 **A Numerical Approximation of Nonlinear Optimization Problems**
Edyta Jacewicz, University of Lodz, Poland

8:40 **Clenshaw-Chebyshev Spectral Method for Discretizing Nonlinear-Constrained Optimal Control Problems**
Gamal N. Elnagar, Illinois Wesleyan University; and Mohammad A. Kazemi, University of North Carolina, Charlotte

9:00 **Numerical Methods for Validation of Solutions of Optimal Control Problems**
Weldon A. Lodwick, University of Colorado, Denver; Arnold Neumaier, Universitaet Wien, Austria; and Francis Newman, University of Colorado Health Sciences Center

9:20 **Sparse-matrix Techniques in Interior-point Methods for Positive Definite Programming**
Lieven Vandenberghe, Katholieke Universiteit Leuven, Belgium

9:40 **Some Numerical Issues in Optimal Control Theory and Applicatons**
Min Sun, University of Alabama, Tuscaloosa

CP18/Directors Row 43

Control and Identification of Distributed Parameter Systems III

Chair: Daniel Tataru, Northwestern University

8:00 **Eigenfrequencies of the Three Dimensional Euler-Bernoulli Beam System with Dissipative Joints**
William H. Paulsen, Arkansas State University

8:20 **A Constructive Method for the Boundary Controllability of a String Network**
Dan Tiba, Institutul de Matematica al Academiei Romane, Romania; and *Marius Tucsnak*, Ecole Polytechnique, France

8:40 **Exact Controllability Properties of Huygens' Equations**
A.Yu. Khapalov, Oregon State University

9:00 **On the Uniform Exponential Stability of the Acoustic-Elastic Interaction System with "Porous" Boundary Condition**
Fariba Fakhroo, Naval Postgraduate School; and Chunming Wang, University of Southern California

9:20 **Robust Output Decentralized Control Applied to Large Flexible Structures**
Arao Fischman, E.R. De Pieri and A. Trofino Neto, LCMI/EEL/UFSC, Brazil

9:40 **Optimizing Controller's Parameters for DPS with a Nonlinear Remez Method**
Seppo Pohjolainen, Tempere University of Technology, Finland

CP19/Directors Row 26

Industrial and Aerospace Applications I

Chair: Paul K.C. Wang, University of California, Los Angeles

8:00 **Thermal Feedback Control of Czochralski Crystal Growth**
Paul K.C. Wang, University of California, Los Angeles; and I. Pawlow, Polish Academy of Sciences, Poland

8:20 **Sliding Mode Control Following of a Reference Electric Power Profile in the Space Nuclear Reactor TOPAZ II**
Yuri B. Shtessel, University of Alabama, Huntsville; and Francis J. Wyant, USAF Phillips Laboratory, Albuquerque

8:40 **Boundedness of Temperature and Stability of the Steady-State Temperature Profile in Thermistors**
Shahram M. Shahruz, Berkeley Engineering Research Institute; and Carlos Kirjner-Neto, University of California, Berkeley

9:00 **On the Nonlinear Regulation of Derived Power Supplies via Discrete Models**
Hebertt Sira-Ramirez, Universidad de Los Andes, Venezuela; and Marisol Delgado, Universidad Simon Bolivar, Venezuela

8:00-10:00
Concurrent Sessions

9:20 **Output-Tracking Controllers Design Using Stable Inversion**
Hongchao Zhao and *Degang Chen*, Iowa State University

9:40 **Decentralized Sliding Mode Control in Integrated Flight Control Problem**
Yuri B. Shtessel, University of Alabama, Huntsville; and Christian H. Tournes, Madison, Alabama

CP20/Directors Row 27
Stabilization and Robustness of Linear Systems

Chair: Pierre Apkarian, CERT-ONERA, France

8:00 **New Conception of Rated Stability of Motion**
Sergey V. Zubov, St. Petersburg State University, Russia

8:20 **Robust Deadbeat Regulators Induced from Single-Input Fixed-Endpoint Optimal Regulators**
Eiji Kondo and Takanori Kiyota, Kyushu University 36, Japan

8:40 **Reliable Control Using Double Two-Parameter Compensators**
Hiroshi Inaba and *Satoru Takahashi*, Tokyo Denki University, Japan

9:00 **S-Procedure for the Analysis of Control Systems with Parametric Uncertainties via Parameter-Dependent Lyapunov Functions**
Eric Feron, Massachusetts Institute of Technology; Pierre Apkarian, CERT-ONERA, France; and Pascal Gahinet, Institute National de Recherche en Informatique et Automatique, France

9:20 **Stability of Linear Periodic System and Its Application in Gain Scheduling Control Analysis**
Jie Yu and Athanasios Sideris, University of California, Irvine

9:40 **Feedback Kalman-Yakubovich Lemma as a Tool of Control Systems Design**
Nikita E. Barabanov, St. Petersburg University of Electrical Engineering, Russia; Alexander N. Churilov, State Marine Technical University, Russia; and *Alexander L. Fradkov*, Russian Academy of Sciences, Russia

10:00/St. Louis E
Coffee

10:30/St. Louis D
IP7/Chair: Christopher I. Byrnes, Washington University

➢ Control of Nonlinear Partial Differential Equations with Applications to Fluid Dynamics

During the past twenty years considerable attention has been devoted to the study of feedback control problems for linear partial differential equations. Much of this work was motivated by applications to structural control (large space structures, flexible robot arms, etc.). In recent years considerable interest has been generated in controlling systems described by nonlinear partial differential equations. Problems arising in the control of fluid flows and structure/fluid interactions have proved influential in this effort. The ability to actively control such systems is an essential ingredient in the development of new "supermaneuverable" aircraft and active flutter suppression. It is clear that practical controllers for such systems must be robust.

Much of the theory developed for linear systems begins with the assumption that the types and locations of actuators and sensors are given in advance. The problem then becomes one of designing the "best" controller for the given configuration. However, the reverse problem is also of considerable importance in practical design. In particular, this problem assumes that the best controller is "given" and the goal is to determine the optimal placement of actuators and sensors in order to maximize the effectiveness of the design.

For nonlinear systems, a satisfactory solution to this problem may help in the development of practical feedback control laws for complex fluid flows. In this talk, the speaker will discuss various mathematical frameworks to address problems of this nature. He will present several problems involving feedback control of fluid flows and illustrate the ideas with some theoretical and computational results for Burgers' equation and Navier-Stokes equations. In particular, he will discuss how robust control theory can be used to help guide sensor placement and actuator design for feedback control.

John A. Burns, Director
Center for Optimal Design and Control
Virginia Polytechnic Institute and
State University

11:30/St. Louis D
IP8/Chair: Kevin A. Grasse, University of Oklahoma, Norman

➢ State-space and I/O Stabilization of Nonlinear Systems

The area of nonlinear feedback stabilization has seen a tremendous amount of activity during the last few years. The speaker will concentrate on various results relating state-space stabilization to input/output stabilization. State-space stability refers to the asymptotic stability of equilibria, or of more general attractors, in the absence of —or subject to only small— external "disturbance" inputs. Input/output stability refers to various definitions all of which focus on bounds on state trajectories expressed in terms of bounds on forcing functions. In many practical situations, state-space stabilization can be achieved by means of linearization under feedback or through the use of appropriate Lyapunov functions. Input/output stability, in contrast, has had a more operator-theoretic flavor and developed independently, often using techniques based on small-gain arguments. In addition, i/o stability provides a framework in which to study the classification and parameterization of dynamic controllers. It is also the most natural notion to consider in the context of building observer-based controllers. Based on linear systems intuition, where all notions coincide, it is perhaps surprising that state-space and i/o stability are not automatically related. Even for feedback linearizable systems, this relation is more subtle than might appear. The speaker will give a survey of results and discuss precise definitions of input to state stability, nonlinear gains, and stability margins which lend themselves to useful theoretical analysis.

Eduardo D. Sontag
Department of Mathematics
Rutgers University

12:30
Lunch

2:00/St. Louis D
IP9/Chair: Irena Lasiecka, University of Virginia

Inverse Problems for Semilinear Elliptic Equations

Consider the semilinear elliptic boundary value problem $\Delta u = -f(u)$ in Ω, $u = 0$ on $\partial\Omega$. In a problem of magnetohydrostatics the function may be thought of as the potential that determines the magnetic flux lines, and Ω may be thought of as the plasma region. The exact form of f is assumed to be unknown — but one has additional information about u. It is an important problem to determine as much as one can about the form of f from the additional information about u (for instance when the goal is to control the location of the plasma region). The most difficult situation arises when this information is restricted to $\partial\Omega$. In this talk, the speaker will discuss several results concerning the identifiability of f based on information about $\frac{\partial u}{\partial n}|_{\partial\Omega}$. The ability to identify f depends crucially on the shape of $\partial\Omega$ as well as on the smoothness properties associated with f. He will also briefly discuss the relation of this type of inverse problem to rather classical conjectures of Pompeiu and Schiffer.

Michael Vogelius
Department of Mathematics
Rutgers University

3:00/St. Louis E
Coffee

3:30-5:30
Concurrent Sessions

MS36/St. Louis D
Applications of PDE Control Methods (Part II of II)

The development and design of practical controllers for infinite dimensional systems described by partial differential equations requires careful modeling and the use of sound computational methods. Applications in structural control, acoustics, fluid flow control and aeroelastic systems have driven much of the research in this area for the past 20 years. In recent years, we have obtained a better understanding of the problems associated with designing practical controllers for specific applications. Moreover, new approaches to modeling, model reduction, approximating systems, nonlinear state estimation and sensor/actuator placement have been developed. In this minisymposium, the speakers will address modeling for control of large periodic structures, present a new uniformly stabilizable numerical method for control of viscoelastic structures, discuss practical passive damping devices for thermoelastic plates and provide a unique approach to the problem of sensor/actuator location for robust control. The speakers are young mathematicians who have recently produced novel mathematical approaches to these practical problems.

Organizers: John A. Burns, Virginia Polytechnic Institute and State University; and H.T. Banks, North Carolina State University

3:30 **Control of Periodic Structures**
Robert Miller, University of Arkansas, Fayetteville

4:00 **Robust Control of a Nonlinear System of Partial Differential Equations**
Belinda B. King, Oregon State University

4:30 **Stabilization of a Thermoelastic Plate by Local Damping**
Z. Liu, University of Minnesota, Duluth

5:30 **On Uniformly Stable Approximations of Partial Differential Equation Systems**
Richard Fabiano, Texas A&M University

MS37/Rose Garden Room
Optimal Control and Nonlinear Controllability (Part II of II)

(For description, see MS24, page 12)

Organizer: Kevin A. Grasse
University of Oklahoma

3:30 **Abnormal Sub-Riemannian Minimizers**
Wensheng Liu, Rutgers University

4:00 **Inverse Optimality Approach to Nonlinear Controller Design**
Randy Freeman and *Petar Kokotovic*, University of California, Santa Barbara

4:30 **Large Time Local Controllability**
Henry Hermes, University of Colorado, Boulder

5:00 **Control Computations for Driftless Systems via Lie Algebraic Methods**
Gerardo Lafferriere, Portland State University

MS38/St. Louis A
Nonsmooth Methods in Optimal Control

Recent developments in nonsmooth analysis and viability theory have provided a number of important new results in optimal control, which allow treatment of a wide range of problems where nonsmoothness appears either directly or via nonsmooth 'auxiliary' functions. Nonsmooth methods now have a prominent role in the characterization of the value function in terms of solutions of the Hamilton-Jacobi-Bellman (HJE) equation (continuous time 'dynamic programming'). Indeed even if the original data is smooth we can expect the value function to have discontinuous derivatives, so we must interpret solutions to (HJE) in some generalized 'nonsmooth' sense. Nonsmooth methods are central also in recently derived necessary conditions of optimality, which are expressed in terms of generalized derivatives of Hamiltonian functions, distance functions, etc, all of which can be nonsmooth even when they originate from smooth problems.

The speakers in this minisymposium will present new results illustrating the rich interplay between nonsmooth analysis, viability theory and optimal control theory, including derivation of optimal and stabilizing controls via nonsmooth solutions to (HJE) and related inequalities and new necessary conditions for optimal control and general variational problems.

Organizers: Helena Frankowska, CEREMADE-Universite de Paris-Dauphine, France; and R.B. Vinter, Imperial College, United Kingdom

3:30 **Equivalent Subgradient Versions of Hamiltonian and Euler-Lagrange Conditions**
R.T. Rockafellar, University of Washington

4:00 **Stabilization of Nonlinear Uncertain Systems**
N. Seube, ENSIETA-BREST, France

4:30 **Refined Necessary Conditions of Optimality for Dynamic Optimal Control Problems with Unilateral State Constraints**
R.B. Vinter, Organizer

5:00 **Optimality Conditions and Feedbacks for Time Optimal Control Problems**
Piermarco Cannarsa, Università di Roma "Tor Vergata", Italy and *Helena Frankowska*, Organizer

MS39/St. Louis B
Stochastic Theory-Adaptive Control (Part II of II)

(For description, see MS27, page 13)

Organizer: Bozenna J. Pasik-Duncan
University of Kansas

3:30 **Analysis of Adaptive Step Size SA Algorithms for Parameter Tracking**
Harold Kushner and J. Yang, Brown University

4:00 **Some Results and Open Problems in Stochastic Adaptive Control**
Han-Fu Chen, Academia Sinica, People's Republic of China

3:30-5:30

Concurrent Sessions

4:30 **Computational Methods for the Stochastic Adaptive Control for an Investment Model**
Tyrone Duncan, Bozenna Pasik-Duncan and Omar Zane, University of Kansas

5:00 **The FCFS Service Discipline: Stable Network Topologies, Bounds on Traffic Burstiness and Delay, and Control by Regulators**
P.R. Kumar and Gil I. Winograd, University of Illinois, Urbana

MS40/St. Louis C

Modeling and Control for Hybrid System (Part II of II)

(For description, see MS34, page 19)

Organizers: Jing Sun and Kenneth R. Butts Ford Research Laboratory

3:30 **Interface Design for Hybrid Control Systems**
Panos Antsaklis, James Stiver, and Michael Lemmon, University of Notre Dame

4:00 **The Algorithmic Analysis of Hybrid Systems**
Thomas A. Henzinger, Cornell University

4:30 **Computation of Discrete State Approximations of Hybrid System Dynamics for Verification and Control**
Bruce Krogh, Carnegie Mellon University

5:00 **Hybrid Models for Automotive Powertrain Systems**
Kenneth R. Butts and Jing Sun, Organizers

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Fuzzy Systems and Intelligent Control

Chair: Wolf Kohn, Intermetrics, Inc., Bellevue, WA

3:30 **Declarative Hybrid Control Architecture: A Schema for Intelligent Control**
Wolf Kohn, Intermetrics, Inc., Bellevue, WA; and Anil Nerode, Cornell University

3:50 **Intelligent Control: A Theoretical Framework**
Dominique Luzeaux, ETCA/CREA/SP, France; and Eric Martin, IDIAP, Switzerland

4:10 **Minimization of the Rule Base of the Fuzzy Logic Controller by Genetic Algorithms**
Alireza Fatehi and Caro Lucas, Tehran University, Iran

4:30 **Fuzzy Programming Procedure Applied to the Solution of Optimising Control Problems of Fuzzy Systems**
Hassan Sidaoui, Centro de Desenvolvimento de Tecnologia e Recursos Humanos, Brazil; and Sadao Isotani, University of São-Paulo, Brazil

CP22/Directors Row 46

Industrial and Aerospace Applications II

Chair: E.E. El-Kholy, Menoufiya University, Egypt and Centre de Recherche en Automatique de Nancy, France

3:30 **Estimation and Control of Sheet and Film Processes**
Richard D. Braatz, University of Illinois, Urbana

3:50 **Comparative Study of Decoupling Terms Compensation Methods for Vector Control of Induction Motor Drives Fed by PWM Voltage Source Inverter**
E.E. El-Kholy, Menoufiya University, Egypt and Centre de Recherche en Automatique de Nancy, France; M. Abdel-Karim and S.A. Mahmoud, Menoufiya University, Egypt; and C. Iung, Centre de Recherche en Automatique de Nancy, France

4:10 **Implementation of Parallel Processing for Field Oriented Control of Induction Motor Drives**
E.E. El-Kholy, Menoufiya University, Egypt and Centre de Recherche en Automatique de Nancy, France; M. Abdel-Karim and S.A. Mahmoud, Menoufiya University, Egypt; and C. Iung, Centre de Recherche en Automatique de Nancy, France

4:30 **Time-Optimal Control of Basic Motion of Tower Cranes**
Ali R. Golafshani and J.D. Aplevich, University of Waterloo, Canada

4:50 **Multiple Shooting Solution of the Optimal Control for a Nonlinear Turbo-Generator Model**
Osman O. Aliyu, University of Bahrain, State of Bahrain and B.J. Olufeagba, University of Ilorin, Nigeria

5:10 **Suboptimal Control of an Electromechanical Robot with Elastic Link**
Sergei A. Mikhailov, Russian Academy of Sciences, Russia and University of Wuppertal, Germany

CP23/Directors Row 26

Stochastic Control, Filtering and Estimation

Chair: Patrick Florchinger, Universite de Metz, France

3:30 **Optimal Control for the Local Time of a Diffusion**
Arthur C. Heinricher, Jr., Worcester Polytechnic Institute; and L. Felipe Martins, Cleveland State University

3:50 **A Class of Nondeterministic Marked Specifications for Supervisory Control**
Martin Fabian and Bengt Lennartson, Chalmers University of Technology, Sweden

4:10 **H_∞-Disturbance Attenuation as a Special Case of Risk-Sensitive Stochastic System: The Nonlinear Partially Observable Case**
Charalambos D. Charalambous, Idaho State University

4:30 **Parameter Uncertainty Intervals (PUIs) in Robust Parameter Estimation**
Hassan Obali and Ahmed Benhammou, Laboratoire d'Automatique et d'Etude des Procedes (LAEP), Morocco

4:50 **Filtering of Markov Process with Partial Observations of its Transitions**
Pavel I. Kitsul, Russian Academy of Sciences, Russia

5:10 **Linear Max-Algebra Models in the Performance Evaluation of Tandem Queueing Systems**
Nikolai K. Krivulin, St. Petersburg State University, Russia

5:30

Conference Adjourns

Interior-Point Polynomial Algorithms in Convex Programming

Yurii Nesterov and Arkadii Nemirovskii

Here is the first unified theory of polynomial-time interior-point methods. This focus on the theoretical aspects allows for new possibilities for constructing efficient methods for nonlinear convex problems. Researchers involved in the development of interior–point methods can investigate more general problems rather than focusing on linear programming.

In many fields of engineering, convex problems arise that are not linear or quadratic, but are of a form that can be handled by these methods. Applications cover a wide variety of difficult important problems, from quadratic programming to finding extremal ellipsoids, from extremal eigenvalue problems arising in control theory to geometric programming. Engineers working with shape design, limits of performance controllers, numerical robust stability analysis, design of structures, optimizing planning, transportation, and oil refinery and allocation will benefit from using these methods.

Audience

Specialists working in the areas of optimization, mathematical programming, or control theory will find this book invaluable for studying interior-point methods for linear and quadratic programming, polynomial-time methods for nonlinear convex programming, and efficient computational methods for control problems and variational inequalities. A background in linear algebra and mathematical programming is necessary to understand the book.

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About the Authors

Yurii Nesterov is Senior Research Associate at the Central Economic and Mathematical Institute, Moscow. Arkadii Nemirovskii is Leading Research Associate at the Central Economic and Mathematical Institute, Moscow.

Special Features

- general theory of path-following and potential reduction interior-point polynomial-time methods for linear and nonlinear convex problems applications to quadratic programming, approximation in LP norms, geometrical programming, constrained minimization of matrix norm, semidefinite programming, and finding extremal ellipsoids
- interior–point methods for variational inequalities
- acceleration of path-following methods

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Mathias, R.C.	MS7	Thu 11:30	5
Mauer, H.	MS30	Fri 9:30	18
McClamroch, N.H.	MS8	Thu 5:00	6
McEneaney, W.M.	MS26	Fri 5:30	12
McMillan, C.	MS23	Fri 4:00	12
Meerkov, S.	MS13	Thu 3:30	7
Megretski, A.	MS25	Fri 4:00	12
Meyn, S.P.	CP1	Thu 12:10	5
Meystel, A.M.	MS32	Sat 8:00	18
Mikhailov, S.A.	CP22	Sat 5:10	22
Miller, R.	MS36	Sat 3:30	21
Miminis, G.	MS14	Thu 4:30	7
Misra, P.	MS14	Thu 4:00	7
Montgomery, R.	MS1	Thu 11:30	4
Mordukhovich, B.	MS24	Fri 4:00	12
Murray, R.	MS15	Fri 9:00	9
N			
Nassiri-Toussi, K.	CP9	Fri 9:20	10
Neittaanmaki, P.	PS	Fri 3:30	14
Nerode, A.	MS34	Sat 8:00	19
Nikoukhah, R.	MS17	Fri 9:00	9

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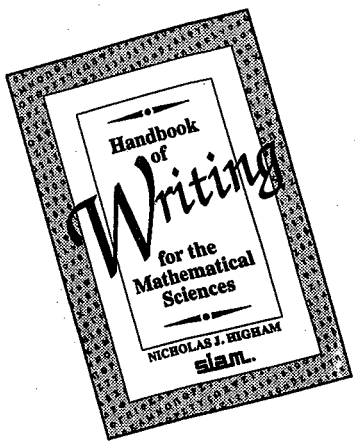
Handbook of Writing for the Mathematical Sciences

Nicholas J. Higham



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Hotel Information

Adam's Mark Hotel

Fourth & Chestnut Streets
St. Louis, MO 63102
Telephone: 314-241-7400
Fax: 314-241-9839

SIAM is holding a block of rooms at the Adam's Mark Hotel. These rooms are being held on a first come, first served basis at $92.00 single or double room. These rooms will be held for our exclusive use only until Friday, March 24, 1995, after which date, reservations will depend on availability.

We urge you to make your reservations as soon as possible. You may do so by calling the Adam's Mark Hotel, faxing your reservation or mailing in the Hotel Reservation Form located on the back of this program. When making your reservation via phone, please be certain to identify yourself as an attendee at the SIAM Conference on Control to receive the discounted rate.

Location: The Adam's Mark Hotel is located in the heart of St. Louis' business, entertainment, and shopping district. Within walking distance you will find: Busch Stadium for Cardinal baseball; Laclede's Landing; the charming riverfront melange of night clubs, restaurants and galleries; the various riverboat attractions along the Mississippi River; the Lewis and Clark Museum beneath the Arch; and the neighboring St. Louis Centre -- a large urban shopping center.

Deposit: To confirm your reservation, a deposit equivalent to one night's room rate is required at the time you make the reservation. Payment can be made by either AMEX, MC, Visa, Diner's Club or check.

Arrivals and Departures: Check-in time is 3:00 PM and check-out time is 12:00 Noon.

Cancellations: If you need to change or cancel your reservation, you must contact the hotel by 1:00 PM Central Time on your stated date of arrival to avoid any unnecessary charges.

Dining: Adam's Mark has three restaurants. Faust's for continental and American cuisine; Faust's Library for the ultimate private dining experience; and Chestnuts, a casual dining area with a true contemporary flavor. There are many other restaurants which offer a variety of cuisines within walking distance of the hotel.

Recreational Facilities: The hotel has a fully equipped fitness center; heated outdoor and indoor pools; aerobic classes; racquetball courts; whirlpools; and saunas. These facilities are complimentary to hotel guests.

Parking: Self parking is available in the hotel garage directly under the hotel. Current prices (10/94) are $9.00 per day maximum, for self park. Valet parking is available at the Chestnut Street entrance. Parking for overnight guests will be charged on the guests room folio. Overnight guests will receive in/out privileges. Local drive-in guests will pay at the garage.

Transportation Information

By Air

Official Carrier for Continental USA and Canada

SIAM has selected TWA as the official carrier for this conference. Discounts are available to conference attendees from April 25 - May 1, 1995.

By flying TWA you become eligible for the following discounts:

- 5% off of the Supersaver Fares (21 day advance purchase with a Saturday night stayover)
- 10% off of Standard Coach Fares (7 day advance purchase with no Saturday night stayover)
- 45% off of Full Coach Fare (less than 7 day advance purchase and no Saturday night stayover)

SIAM has selected Get-A-Way Travel agency to assist attendees in making travel arrangements. Get-A-Way Travel will make your reservations on TWA or any airline of your choice. To take advantage of the TWA discounts, you must book your reservation through Get-A-Way Travel by calling 1-800-223-3863 or 215-379-6800. Ask for Carol Brecht. Be sure to mention that you are attending the 1995 SIAM Conference on Control. Get-A-Way Travel will issue your tickets and mail these to you.

Car Rental

Dollar Rent A Car has been selected as the official car rental agency for this conference. The following rates are available to attendees between April 20 - May 4, 1995. Dollar is located in-terminal at the Lambert-St. Louis International Airport. Attendees will also earn frequent flyer miles from United, TWA or Continental Airlines when renting from Dollar Rent A Car. All rentals include unlimited mileage.

Type of Car	Daily Rate (1-4 days)	Weekly Rate (5-7 days)
Compact	$31.00	$155
Intermediate	$34.00	$170
Standard	$35.00	$175
Luxury	$44.00	$220
MiniVan	$45.00	$225

Additional charges:
$9.00/day Loss Damage Waiver
$4.95/day Personal Accident Insurance & Personal Effects Protection

Reservations

We encourage you to make advance reservations, as on-site availability cannot be guaranteed. Make reservations by calling Dollar Rent A Car at (800) 800-0044. Be sure to mention that you are attending the 1995 SIAM Conference on Control, April 27-29, 1995, in St. Louis, Missouri, in order to receive the discounted rates.

- Cars must be picked up and returned to the same location.
- You must be at least 25 years of age and have a valid U.S. or International Drivers License.
- You must have one of the following credit cards to rent a car: American Express, MasterCard, or VISA.
- Refueling charges, collision insurance, and taxes are not included in the above rates.

On occasion, the car rental agency may offer special rates that are lower than rates quoted above. As an attendee, you are eligible for the lower of the two rates. In most instances, the conference discount rates are lower than those quoted to the general public.

Airport Transportation

Getting to and around in St. Louis is easy! St. Louis is served by Lambert-St. Louis International Airport. Commercial shuttle bus service is available through Airport Express at 314-429-4950 from 6:40 a.m. to 10:30 p.m. The daily service from the airport to most downtown hotels is approximately $8.00 one way or $14.00 round trip. Cab fare from the airport is approximately $20.00.

Driving Directions to the Adam's Mark Hotel

From the Airport: Take Highway 70 east and exit at Memorial Drive. Make a right at Market Street, a right at Fourth Street and a right at Chestnut Street.

From the North: Take Highway 55 and exit at Memorial drive. Make a left at Market Street. Make a right at Fourth Street. Make a right at Chestnut Street.

From the East: Take Highway 40 and exit at Broadway (last Missouri exit). Make a left at Cerre Street. Go 2 blocks east to Fourth Street and make a left. Go north 3 blocks and make a right at Chestnut Street.

From the West: (From Highways 55, 70, 40 and 64 West) Follow the highway over the Poplar Street Bridge, exit at Memorial Drive. Make a left at Market Street, right at Fourth Street and a right at Chestnut Street.

Registration Information

The registration desk will be located at the entrance of the St. Louis Ballroom located on the fourth floor. The registration desk will be open as listed to the right:

Wednesday, April 26	5:00 PM - 7:00 PM
Thursday, April 27	7:00 AM - 7:00 PM
Friday, April 28	7:30 AM - 3:30 PM
Saturday, April 29	8:00 AM - 1:00 PM

Registration Fees

Preregistration deadline: Friday, April 14, 1995.

		SIAG/CST*	SIAM Member	Non-Member	Student
Conference	*Before 4/14*	$145	$150	$180	$40
	After 4/14	$175	$180	$210	$40

*Member of SIAM Activity Group on Control and Systems Theory.

To register, complete the Preregistration Form in the back of this program and return it with your payment to SIAM. You can also register in the following ways:

- Telephone: 215-382-9800; Toll free-800-447-7426 (USA only).
- E-mail: meetings@siam.org
- Fax: 215-386-7999

We urge attendees to preregister and save!. To qualify for the preregistration fee, the Preregistration Form and payment must be received at the SIAM Office by Friday, April 14, 1995.

Preregistration received at the SIAM office after Friday, April 14, will be subject to the difference between the preregistration and the on-site registration fees ($30). The difference will be charged to your credit card or collected from you on-site.

There will be no prorated fees. No refunds will be issued after Wednesday, April 26, 1995.

On-site registration begins on Wednesday, April 26, 1995. If your preregistration payment arrives at SIAM after the conference has started, that payment will returned to you. Your on-site registration will be processed.

Hotel Roommate-Sharing Database

SIAM will keep a database of attendees who may wish to share a room with another attendee at the conference to cut down on expenses. To be placed on this database, you must forward the following information via e-mail to: peirce@siam.org or by fax: 215-386-7999. BE SURE TO MENTION THAT YOU ARE INTERESTED IN THE CONTROL CONFERENCE DATABASE.

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Arrival/Departure Dates

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April 15-26, 1995	$25.00 Cancellation Fee
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The telephone number of the Adam's Mark Hotel is 314-241-7400. The Adam's Mark will either connect you with the SIAM registration desk or forward a message to the attendees room.

Control and Its Applications

HOTEL RESERVATION FORM

Please send me a confirmation

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Name _____

Address _____

City _____ State _____ Zip _____

Phone _____

Please reserve a [ ] $92/Single _____ [ ] $92/Double

Arrival Date _____ Arrival Time _____ Departure Date _____

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Specially discounted rooms are being held for our exclusive use until Friday, March 24, 1995. After that date, reservations will depend on availability. Your reservation is not confirmed until acknowledged in writing by the hotel or verified by phone. A deposit in the amount of one night's room rate is required in order to confirm your reservation. When making reservations by phone, be certain to identify yourself as an attendee at the SIAM Conference on Control. The Adam's Mark Hotel telephone: 314-241-7400 or fax: 314-241-9839.

Control and Its Applications

PREREGISTRATION FORM

REGISTRATION FEES

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For your convenience, you can register in any of the following ways:

- **By Phone:** 215-382-9800; Toll free: 800-447-7426 (USA Only)
- **By E-mail:** meetings@siam.org
- **By Fax:** 215-386-7999
- **By Mail:** Complete and return this form and payment to: SIAM Conference Department, 3600 University City Science Center, Philadelphia, PA 19104-2688 U.S.A.

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☐ I am a disabled participant and require appropriate accommodations.

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