M11 : Switched Systems and Control

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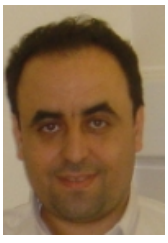
This course will examine switched systems from a control-theoretic perspective. The main focus will be on stability analysis and control synthesis of systems that combine continuous dynamics with switching events.

We will start with an introduction to the basic concepts and definitions for hybrid and switched systems. In the analysis part of the course, we will develop stability theory for switched systems. Here we will cover single and multiple Lyapunov function methods, stability criteria based on commutation relations, stability under slow switching, and stability of switched systems with various types of useful special structure. The case of discrete time switched systems will also be presented. Computational techniques and properties beyond traditional stability (such as invertibility, flatness, etc) will be discussed.

The later portion of the course will be devoted to switching control design. We will describe several wide classes of continuous-time control systems for which the logic-based switching paradigm emerges naturally as a control design tool. Specific instances of this include: systems not stabilizable by continuous feedback (such as nonholonomic systems), systems with sensor or actuator constraints (such as quantized feedback systems), and systems with large modeling uncertainty (for which we will discuss switching adaptive control techniques). This course will also introduce some control applications where switched systems framework plays a major role (Digital control for switched systems with uncertain switching, time varying delay and non uniform sampling, Networked control and Steering control).

The course is suitable for engineering and mathematics students who are familiar with basic linear system theory. Along the way, we will introduce/review several more advanced concepts from mathematical control theory which are required in the course but also are important in their own right: Lyapunov and LaSalle theorems, Lie brackets of vector fields, maximum principle of optimal control, nonholonomic constraints, input-to-state stability, and others. Proofs of most results will be presented.

Daniel Liberzon was born in the former Soviet Union on April 22, 1973. He was a student in the Department of Mechanics and Mathematics at Moscow State University from 1989 to 1993 and received the Ph.D. degree in mathematics from Brandeis University in 1998 (under the supervision of Prof. Roger W. Brockett of Harvard University).
Following a postdoctoral position in the Department of Electrical Engineering at Yale University from 1998 to 2000, he joined the University of Illinois at Urbana-Champaign, where he is now an associate professor in the Electrical and Computer Engineering Department and a research associate professor in the Coordinated Science Laboratory.
Dr. Liberzon's research interests include nonlinear control theory, analysis and synthesis of switched systems, control with limited information, and uncertain and stochastic systems. He is the author of the book *Switching in Systems and Control* (Birkhauser, 2003) and the author or coauthor of over thirty journal articles on the above topics. Dr. Liberzon received the IFAC Young Author Prize and the NSF CAREER Award, both in 2002, and was elected a senior member of IEEE in 2004. He received the Donald P. Eckman Award from the American Automatic Control Council in 2007, and the Xerox Award for Faculty Research from the UIUC College of Engineering also in 2007. He delivered a plenary lecture at the 2008 American Control Conference. Since 2007, he serves as Associate Editor for the IEEE Transactions on Automatic Control.



Jamal Daafouz was born in Nador, Morocco, in 1971. He received the Engineer's Degree and the Masters' Degree with specialization in control from the Institut National des Sciences Appliquées (INSA, National Institute for Applied Sciences), Toulouse, France, in September 1994. From October 1994 to August 1997 he was a Ph.D. student at LAAS - CNRS in Toulouse, France. He received Ph.D. degree from INSA Toulouse in October 1999, the French Habilitation degree from the Institut National Polytechnique de Lorraine (INPL) in Nancy, France in June 2005. From September 1998 to August 2005, he was an associate professor at INPL and a researcher at the Research Centre of Automatic Control (CRAN) in Nancy. He got a full professor position at INPL in September 2005.

Jamal Daafouz is an Associate Editor at the Conference Editorial Board of the IEEE Control Systems Society since 2005. He serves also as an associate editor for the journals : Nonlinear Analysis : hybrid systems (since 2007), and the french journal “Journal Européen des Systèmes Automatisés JESA”.

Jamal Daafouz's research interests include switched systems, linear parameter varying systems, robust control with application to secure communications.