# MATHEMATICAL TOPICS IN SYSTEMS THEORY

Instructor: Michael A. Malisoff
Fall 2003, MATH 7380-2, MWF 11:40-12:30

This course provides a basic introduction to the mathematics of finite-dimensional, continuous-time, deterministic control systems at the beginning graduate student level. The course is intended for PhD students in applied mathematics, and for engineering graduate students with a background in graduate real analysis and nonlinear ordinary differential equations. It is designed to help students prepare for interdisciplinary research at the interface of applied mathematics and control engineering. This will be a rigorous, proof-oriented systems theory course that goes beyond classical frequency-domain or more applied engineering courses. Emphasis will be placed on controllability and stabilization. The main course topics will be selected from the following:

A. Introduction to mathematical control theory: feedbacks vs. pre-computed controls, outputs, dynamic feedback.
B. Systems: Input/output behaviors, continuous-time control systems, linearizations, sampling, Volterra expansions.
C. Reachability and controllability: controllable pairs of matrices, controllability under sampling, first-order local controllability.
D. Nonlinear controllability: Lie brackets, Lie algebras and flows, Frobenius Theorem, accessibility rank condition.
E. Feedback and stabilization: stability and other asymptotic notions, Lyapunov and control-Lyapunov functions, linearization principle.
F. Optimality: value functions, linear systems with quadratic costs, infinite-time steady-state problems, Maximum Principle.

TEXTBOOK: Sontag, E.D., *Mathematical Control Theory, Deterministic Finite-Dimensional Systems, Second Edition*, Texts in Applied Mathematics Vol. 6, Springer-Verlag, New York, 1998 (ISBN: 0-387-98489-5). Additional material as appropriate from papers by lecturer available at `www.math.lsu.edu/ ∼ malisoff/research.html`.

PREREQUISITES: MATH 7311 (Real Analysis I), MATH 7312 (Measure and Integration), and MATH 7320 (Ordinary Differential Equations), or permission from the instructor.