OPTIMAL CONTROL THEORY
(Proposed Course)

Instructor: Michael A. Malisoff

This course will present a modern introduction to deterministic, finite-dimensional optimal control, emphasizing recently-developed techniques based on dynamic programming and nonsmooth analysis. The course topics will be of interest to engineering students and others in the applied sciences who wish to learn about recent mathematical theory and classical methods of dynamic programming for constrained optimization problems, and to mathematicians interested in new methods for first-order nonlinear PDEs and their applications. Topics for this course will be selected from the following list:

A. Overview of optimal control: derivation of the Hamilton-Jacobi-Bellman equation (HJBE) from Dynamic Programming Principle, Maximum Principle, viscosity solutions of HJBEs, approximation of value functions. Basic theory of viscosity solutions, relationship to other theories of set-valued differentials such as Generalized Subgradients.

B. Finite-horizon, infinite-horizon, and exit-time deterministic optimal control, including dynamic programming and HJBEs. Optimal stopping, impulse control, state constraints. Existence and uniqueness for viscosity solutions of HJBEs, new results on the uniqueness of HJBE solutions for infinite-horizon and exit-time problems for degenerate Lagrangians.

C. Application of optimal control techniques to other areas, such as two-person zero-sum differential games and viscosity solutions of the Isaacs Equation, singular perturbations, construction of robust Lyapunov functions, and computation of robust domains of attractions for locally uniformly asymptotically stable systems.

D. Fully-discrete approximation schemes for the value function and for optimal feedback controls based on dynamic programming, uniqueness characterizations for HJBE solutions, and simplicial decompositions. Approximation of the minimal time function in optimal control. Error bounds for discretization errors. Applications to Lyapunov theory.


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