ELEG 5423 Optimal Control

Spring 2006: T-Th, 12:30-1:50 PM, Bell 288

Text: An Engineering Approach to Optimal
Control and Estimation Theory by George
Siouris (Wiley).

Instructor: Roy McCann, Ph.D., P.E.

Robert Stengel

This course covers the introductory theory of optimizing dynamic systems. The scope is the classical and "modern" methods that are often used or referenced in recent engineering research and practical applications. There is a large body of knowledge for optimizing the solutions to many types of problems in the quantitative sciences. This is evidenced by running a library keyword search on "optimal," "optimization," "optimized," etc. However, this course focuses on real-time systems where the variables of interest are functions of time and the optimal solution if often computed during system operation. Early applications were for aircraft, missile and space systems where there are hard constraints on mass, time and fuel usage. However, optimal control and estimation theory has been applied to many diverse applications, including robotics, biomedical and automotive system.

This course covers deterministic and stochastic signals and systems. A familiarity with linear systems theory is assumed, but most of the mathematical background for random processes will be covered within the course. This course will also provide detailed use of Matlab-Simulink in formulating design solutions to engineering problems. As time allows, the last portion of the class will cover emerging areas such as genetic algorithms, neural networks, and swarm theory.

Outline

1. Mathematical Preliminaries (Chapter 2: 6 class meetings)
    a. Continuous-time random processes
    b. Discrete-time random processes
    c. State Space Models
    d. Markov Processes
2. Quadratic Based Optimization (Chapter 5: 10 classes)
    a. Control, Estimation and Identification
    b. Classical Wiener Filter
    c. Linear Regulators & Solution to Ricatti Equations
    d. Linear Quadratic Gaussian Control
3. Kalman Filter (Chapters 4, 6 and 7: 8 classes)
    a. Continuous-time
    b. Discrete-time
    c. Suboptimal and Steady-State Solutions

4. Intelligent Methods (6 class meetings)
   a. Artificial Neural Networks
   b. Genetic Algorithms
   c. Swarming Theory

Class Project

A Matlab-Simulink based class project is required for the course. The topic can be selected by the student or a problem provided by the instructor can be used. The purpose is to more deeply explore the implementation details than what can be accomplished in the homework assignments.

Grading:

4 homework (small project) assignments	40% (combined)
2 In-Class Exams (20% each)	40% (combined)
Class Project (counts as final exam)	20%