ECE 5555 (Fall 2018) **Syllabus**

Stochastic Systems: Estimation and Control

1 Course Description

The problem of sequential decision-making in the face of uncertainty is ubiquitous. Examples include: autonomous vehicles, high frequency trading, power system operations, air traffic control, livestock and fishery management, supply chain optimization, internet ad display, data center scheduling, and many more.

In this course, we will explore the problem of optimal sequential decision making under uncertainty over multiple stages—*stochastic optimal control*. We will discuss different approaches to modeling, estimation, and control of discrete time stochastic dynamical systems (with both finite and infinite state and action spaces). Solution techniques based on dynamic programming will play a central role in our analysis. Topics include:

- Fully and partially observed Markov decision processes
- Optimal stopping (e.g., secretary) problems
- Kalman filtering
- Linear quadratic Gaussian (LQG) control
- Model predictive control (MPC)
- Adaptive control and online learning
- Approximate dynamic programming (time permitting)
- Decentralized stochastic control (time permitting)
- Applications to various domains will be discussed throughout the semester.

2 Instructor Information

Instructor:	Eilyan Bitar
Office:	326 Rhodes Hall
Office Hours:	Tuesday 1:10 - 3:00 PM (or by appointment)
Email:	eyb5@cornell.edu
Phone:	(607) 255-7156

3 Lectures

Lectures will be held Tuesday/Thursday (11:40 - 12:55 PM) in 362 Hollister Hall.

4 Textbooks

There are two required textbooks for this course:

1. D. Bertsekas. *Dynamic Programming and Optimal Control.* Volume I, 4th ed. Nashua, NH: Athena Scientific, 2017.
2. P. R. Kumar and P. Varaiya. *Stochastic Systems: Estimation, Identification and Adaptive Control.* Society for industrial and applied mathematics (SIAM), 2015.

5 Prerequisites

Comfort with mathematical proofs, multivariable Calculus, probability, linear algebra, (basic) convex analysis, and basic Matlab (or Python) programming.

6 Grading

Your final grade will be based on **homework** (55%, assignments equally weighted), **project proposal** (5%), and **final project** (40%).

7 Collaboration and Code of Conduct

Every student attending this course is expected to abide by the Cornell University Code of Academic Integrity, which can be found at cuinfo.cornell.edu/Academic/AIC.html. Any piece of work you turn in for credit must be your own work. Discussion with other students about specific homework problems is permitted to the extent that discussion is limited to problem approach and does not include note taking. In writing up your homework solution, you must acknowledge anyone with whom you collaborated. If you use papers or books or other sources (e.g. material from the web) to help obtain your solution, you must cite those sources. You may not discuss exam problems with other students. Please ask if you are unclear as to what constitutes excessive collaboration.

8 Misc

The final project presentations will take place outside of normal lecture times. This additional time commitment outside of normal class hours will take the place of 2 to 3 regular lectures.