ENEE 762 Stochastic Control –fall 2020, Tu Th 5:00 – 6:15; ONLINE
Instructor: P. S. Krishnaprasad; Contact: 301-405-6843, room 2233 A. V. Williams Building;
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This is a course on stochastic models, problems, and methods. The focus will be on filtering and (feedback) control. Continuous time models built on differential equations subject to noise processes (fluctuations) with continuous sample paths will be central to the course. Classic examples of this setting, such as the Kalman-Bucy filter, and linear stochastic optimal control with quadratic cost functionals will be worked out. In the setting of discrete time stationary processes applications to prediction and minimum variance control will be presented. This will be followed by discussion of processes with jumps (e.g. processes *driven by* Poisson counters as in the Notes by Brockett – see below). Models with counting *measurement* processes will also be discussed, with motivation from biology (neuroscience) and physics. Examples such as the Wonham filter and later developments in nonlinear filtering will be of interest. Making sense of the continuous time models and their solutions will require understanding *stochastic integrals*. For linear equations this is not a large step, but for nonlinear problems we use methods of **Ito** and **Stratonovich** leading to stochastic calculus. We will give a self-contained treatment of stochastic calculus with a rich collection of examples. Models extending state machines, leading to classic solvable problems of Markov Decision Processes (MDP), and Partially Observable Markov Decision Processes (POMDP) will also be discussed. Time permitting, applications of these models and solutions to planning and learning problems in autonomous systems (robotics) will be explored.

This course would be of interest to students in engineering (control, communication and signal processing, estimation), computer science (AI planning and robotics), biology (sensorimotor aspects of neuroscience and cognitive science of decision-making), and physics (control of non-equilibrium phenomena).

References - Textbooks:
1. Introduction to Stochastic Control Theory by **Karl Johan Åström** (Dover edition, 2006)
2. An Introduction to Stochastic Differential Equations by **Lawrence C. Evans** (AMS, 2014)
3. Dynamic Programming and Optimal Control vol. I by **Dimitri Bertsekas** (Athena 2017)
4. Estimation and Control of Dynamical Systems by **Alain Bensoussan** (Springer 2018)
5. Stochastic Processes in Engineering Systems by **Eugene Wong and Bruce Hajek** (Springer 1985)
6. Stochastic Tools in Mathematics and Science by **Alexandre J. Chorin and Ole H. Hald** (Springer 2013)

References - Notes:
1. Lecture Notes by the instructor will be distributed.
2. Notes on Stochastic Control by **Roger W. Brockett** (2009) will be distributed.

Prerequisites: Probability and Random Processes, Differential Equations & Control Theory, both at graduate level, comparable to ENEE 620 and ENEE 660. Instructor may be contacted for clarification.

Grading: A mix of homework problems, projects and exams – details will be available in the beginning of August.