EE546: Special Topics in Control Systems

Stochastic Processes in Nanoscale Systems

Winter 2008
MW, 9:30 am -- 10:50 am
EEB 026

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Description: In this course I will introduce the mathematical theory of stochastic processes and apply the theory to models of nanoscale systems such self-assembly, low-copy-number chemical reactions and single-cell gene regulatory networks. Topics will include a measure theoretic approach to stochastic processes, the master equation, intrinsic versus extrinsic noise, the Fokker-Plank equation, the Langevin equation, moment dynamics and truncation, stochastic simulation, and the approximation of stochastic processes by nearby processes. Special attention will be given to the control of the above-mentioned stochastic processes using feedback. The course assumes a basic familiarity with probability and differential equations. EE505 and/or EE508 may be helpful background, but are not required. The course is open to all engineering and science graduate students.

Text: *Stochastic Processes in Physics and Chemistry* by N. G. Van Kampen.

Software: *Mathematica* 6.0 or higher.

Weekly Homework: There will be an assignment due each Monday in class (unless otherwise noted). Homework is worth 60% of your grade in the course. Each assignment will include two parts: (a) A set of problems usually chosen from the text; (b) An example problem made up *by you* about a system that *you choose* and that you will revisit each week. I will grade one randomly chosen problem from part (a) and all of part (b). ***Please turn in very concise and neat homework.***

Project: You will build up the content of a course project throughout the course (see above) and through independent work. On the last day of class, you will present a five-minute overview of the system you studied. At the end of finals week, you must turn in a project report, worth 20% of your grade. The project report must include:

a) A description of a stochastic system or systems that you choose, related to your research interests;
b) A set of questions about the system in works and in as mathematical terms as possible;
c) A literature review describing related approaches to modeling and analyzing systems similar to yours;
d) Results of simulations of your system and an explanation of how they address the questions in (b);
e) An analysis of your system with an explanation of how your analysis addresses the questions in (b);
f) A discussion and conclusion.

Take-Home Final: There will be a final consisting of a number of analysis questions worth 20% of your grade. This will be assigned on the last day of class and due during finals week.

Schedule: We will attempt to cover, at a rate of about one chapter per week, chapters I-VIII, chapter X and a number of special topics for which papers from the literature will be provided.