ENG SE/EC/ME733: Discrete Event and Hybrid Systems

Description:
Prereq: EK500 or EC505 or consent of instructor.
This course is intended for graduate students interested in learning about Discrete Event Systems (DES) and their applications, as well as more recently emerging Hybrid Systems (HS) that combine both continuous (time-driven) and discrete (event-driven) dynamics. The first part of the course covers modeling frameworks for DES, including Automata, Timed Automata, Stochastic Timed Automata, Petri Nets, and Queueing Systems. These frameworks, combined with classical time-driven dynamic system models, give rise to HS models such as Hybrid Automata. In the second part of the course, this material is used to introduce Monte Carlo Computer Simulation in order to build and analyze simulation models of complex dynamic systems. Applications focus on computer networks, sensor networks, manufacturing, supply chains, transportation, robotics, command-control environments, and some more exotic cutting-edge research areas. The third part of the course covers more advanced material on control and optimization of DES and HS. Topics covered include Dynamic Programming and Markov Decision Processes (MDP) with applications to scheduling, resource allocation, and gambling problems; Stochastic Approximation algorithms for adaptive (on-line) control and optimization; Perturbation Analysis and Rapid Learning methods for DES and HS. Recent developments in Stochastic Resource Contention Games will be included.

4 cr.

Class Schedule:
Lecture: 4 hours/week

Textbook:

Other References:

Instructor:
Christos G. Cassandras, Professor, ECE Department and Division of Systems Engineering

Course Outline:
1. Review of system theory fundamentals  
2. Untimed DES Models: Automata, Petri Nets  
3. Timed Models: Timed Automata, Timed Petri Nets, max-plus algebra models  
4. Monte Carlo computer simulation: principles, pitfalls, applications using commercial software tools (e.g., SimEvents see http://www.mathworks.com/products/simevents/)  
5. Stochastic models, queuing theory  
6. Markov Decision Process theory  
7. Perturbation Analysis and Rapid Learning methods  
9. Introduction to the analysis and control of Hybrid Systems  

**Goals:**  
One of the objectives of this course is to help students develop the ability to conceptualize cutting-edge technological issues in the DES and HS domain, formulate problems, and organize their thought process for research purposes. There are some homework assignments. Students are expected to make class presentations. Final course projects are assigned, depending on student interests or their ongoing research projects (if applicable) and are the main factors for grade determination. There are no exams.