SYST 611 - System Methodology and Modeling

Theme: Foundations and applications of Dynamic Modeling

The approaches presented in this course are primarily concerned with capturing a system's behavior and changes over time. Due to the inherent interdisciplinary nature of the field of dynamic modeling, an effort is made to present a variety of modeling methodologies from different disciplines, e.g., engineering, computer science, economics, etc., together with their applications to non-trivial, real-world systems. Different model types (or languages) are characterized by way of representations, i.e., graphical or text-based grammars.

The course starts with a general introduction to dynamic models. The state machines are presented as the simplest and general method for modeling dynamic systems. The issues of composition, abstraction, and execution of models, are illustrated with the help of state machines. The same issues are revisited with each of the modeling formalism covered in the course.

Continuous and discrete time systems are presented as special classes of state machines. Different representational formalisms (e.g., operator equations, difference/differential equations, block diagrams) are presented by highlighting their representational and computational (dis)advantages over others. System Dynamics is presented as a computer-aided approach to modeling complex domains (e.g., social and economic.)

Discrete event systems (DES) are introduced as another class of dynamic systems. A review of concepts from Discrete Mathematics, that are relevant for DES modeling, is done to prepare students for more in-depth study of DESs. This review includes a short introduction to topics in Sets, Discrete Probability, Graph Theory, Logic, and Languages and then illustrates how these are used within dynamic systems modeling.

A number of DES modeling and simulation formalisms and techniques are introduced as extensions to Finite State Machines (FSM). These formalisms are presented as means to capture both a system's specifications and its behavior. This presentation is accompanied by several modeling examples of DES.

The course concludes with an introduction to the topics of modeling stochastic behavior and decision analysis.

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Spring 2013: Wednesdays 4:30 – 7:10 PM

Room 3511 Nguyen Eng. Building & On-line via Blackboard Collaborate (http://mymason.gmu.edu)

Office Hours: Wednesdays 3:00 – 4:30 PM and by appointment

Hardware/Software Requirements

A part of this course requires students to implement dynamic models using some software. These software will be introduced in-class and information to download them will be provided via Blackboard. Students are required to have the software ready for use on their individual computers for the homework assignments.

Proposed Course Structure

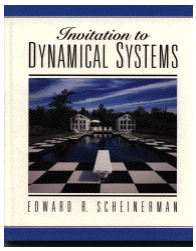
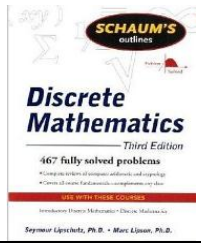
S.No.	Topics	No. of Lectures Required	Support Material / Software	Relevance to SE Concentration Tracks
1.	Definitions and Taxonomy of System Types and Models Synthesis, Analysis, and Theory of Models • State Machines	1	Handout	All tracks
2.	Linear Time Invariant (LTI) Systems • Continuous Time and Discrete Time Systems Nonlinear Systems • Stability • Linearization	4	B1(Chapters 1 to 5) and handouts Some use of Matlab software (optional)	C4I,FSE, ATS, and ABSI
3.	System Dynamics • Modeling Examples of Real World Systems	2	Handout and online supplementary material Some use of Vensim software	ABSI, ATS, C4I and FSE
4.	Overview of Concepts from Discrete Mathematics for the Study of Discrete Event Systems (DES)	1	B2 (Chapters 1-4, 7-8, 12-13) and handouts	ABSI, C4I, SIS, SEA
5.	Discrete Event Systems (DES) Modeling and Simulation • Finite State Machines • DEVS • Process Algebra • Petri Nets	3	Handouts Some use of CPN Tools and Yawl software	ABSI, ATS, C4I and SMG
6.	Stochastic Systems • Decision Analysis • Markov Chains	2	B1 and handout	C4I, SEA, SMG, and FSE

Tentative Course Schedule (subject to change as the course progresses)

Date	Lecture Topic(s)
23-Jan-13	Introduction to Systems, System Taxonomy, Review of Mathematical Concepts
30-Jan-13	Modeling Concepts; State Machines
6-Feb-13	Discrete-Time Systems (Linear)
13-Feb-13	Discrete-Time Systems (Non-Linear)
20-Feb-13	Continuous-Time Systems (Linear)
27-Feb-13	Continuous-Time Systems (Non-Linear)
6-Mar-13	System Dynamics
13-Mar-13	*Spring Break*
20-Mar-13	**Midterm**
27-Mar-13	Discrete-Event Systems
3-Apr-13	Finite-State Machines
10-Apr-13	DEVS
17-Apr-13	Process Algebra
24-Apr-13	Petri Nets
1-May-13	Stochastic Systems
8-May-13	**Final Exam**

Reading and Reference Material:

a) Required

Book Id.	Title	Comment
B1	Invitation to Dynamical Systems By Edward R. Scheinerman 	Required text for continuous and discrete time dynamical systems (the first half of the course.)
B2	Schaum's Series on Discrete Mathematics 	Required text for review of Discrete Mathematics

1) Handouts/Lecture notes prepared by the instructor.
2) Supplementary Material: A collection of relevant papers made available via Blackboard

Student Evaluation Criteria: Homework 50%; Midterm 25%; Final 25%