George Mason University **The Volgenau School of Engineering**

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.

Instructor: Prof. Abbas K. Zaidi
SEOR, Nguyen Eng. Room 2237
Ph: 703 993 1774
szaidi2@gmu.edu

Fall 2013: Tuesdays 4:30 – 7:10 PM

Robinson Hall B111

Office Hours:

Tuesdays 2:30 – 4:20 PM
Wednesdays 5:30 – 7:20 PM
and by appointment (via email)

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.

Overview of Course Structure

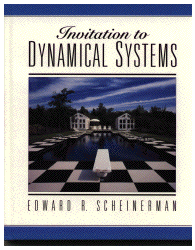
S.No.	Topics	No. of Lectures Required	Relevance to SE Concentration Tracks
1.	Definitions and Taxonomy of System Types and Models Synthesis, Analysis, and Theory of Models • State Machines	1	All tracks
2.	Linear Time Invariant (LTI) Systems • Continuous Time and Discrete Time Systems Nonlinear Systems • Stability • Linearization	4	C4I,FSE, ATS, and ABSI
3.	System Dynamics • Modeling Examples of Real World Systems	2	ABSI, ATS, C4I and FSE
4.	Overview of Concepts from Discrete Mathematics for the Study of Discrete Event Systems (DES)	1	ABSI, C4I, SIS, SEA
5.	Discrete Event Systems (DES) Modeling and Simulation • Finite State Machines • DEVS • Process Algebra • Petri Nets	3	ABSI, ATS, C4I and SMG
6.	Stochastic Systems • Decision Analysis • Markov Chains	2	C4I, SEA, SMG, and FSE

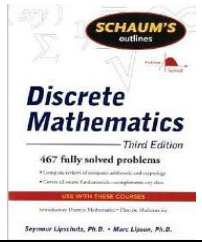
Tentative Course Schedule (subject to change as the course progresses)

Date	Lecture Topic(s)
27-Aug	Introduction to Systems, System Taxonomy, Review of Mathematical Concepts
3-Sep	Modeling Concepts; State Machines
10-Sep	Finite-State Automata
17-Sep	Finite-State Automata Composition
24-Sep	Discrete-Time Systems I
1-Oct	Discrete -Time Systems II
8-Oct	Continuous -Time System
15-Oct	*No Class (Monday classes meet Tuesday.)*
22-Oct	**Midterm**
29-Oct	System Dynamics I
5-Nov	System Dynamics II
12-Nov	***Student Presentations***
19-Nov	Discrete Event Systems with Petri Nets
26-Nov	Discrete Event Systems, DEVS
3-Dec	Decision Analysis
10-Dec	**Final Exam**

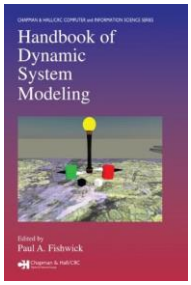
Reading and Reference Material:

a) Required

Book Id.	Title	Comment
1	Invitation to Dynamical Systems By Edward R. Scheinerman 	Required text for continuous and discrete time dynamical systems (the first half of the course.) ***Available Online*** *(by the author)*

2	Schaum's Series on Discrete Mathematics 	Strongly recommended for review of Discrete Mathematics' concepts

a) Recommended

3	Handbook of Dynamic System Modeling By Paul A. Fishwick (Editor) Chapman & Hall/CRC Computer & Information Science Series Publication Date: June 1, 2007 | ISBN-10: 1584885653 | ISBN-13: 978-1584885658 | Edition: 1	Recommended as a reference handbook 

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%