SYST 611
SYSTEM METHODOLOGY AND MODELING

Spring 2015

Department of Systems Engineering and Operations Research

George Mason University

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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Office Hours: Tuesday and Thursday 3:00 – 4:00 PM and by appointment via phone/email (preferred)

Teaching Assistant: TBD

Class Information:

When: January 20 – May 13, Spring 2015

Where: All course communication will be done via the Blackboard system. Students are expected to have access and be able to use the system before classes start. Blackboard is accessible via MyMason portal at https://mymasonportal.gmu.edu/. Instructions for using the Blackboard system are provided on the Help button at the top right of the portal page.

Office Hours: Tuesday and Thursday 3:00 – 4:00 PM and by appointment via phone/email (preferred)

Learning Objectives & Outcomes

The ability to effectively apply the concepts of systems engineering in the modeling and analysis of real life systems by identifying the appropriate modeling formalism for the system under study, formulating the analysis questions of interest, selecting the suitable analysis method for the study, and employing the state-of-the-art software tools to carry out the tasks.

By completing this course a student should be able:

- To classify a given system in a class of systems of known characteristics
- Based on the classification above, to identify a suitable abstraction (modeling approach) for modeling the behavior of the system
- To identify the analysis questions that can be addressed by the modeled system
- To start developing a systems engineer's toolkit for modeling and analysis of dynamic systems

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

The following scale can be used by students for self-assessment. The instructor may relax the grading scheme for final grade assignment.

94-100	**A**
88-93	**A-**
83-87	**B+**
77-82	**B**
70-76	**B-**

Attendance and Participation Requirements

There are no specific attendance and participation requirements, other than the following:

- Midterm Examination on February 26, 2015, from 4:30 pm to 6:30 pm. This live session is optional and can be used by students who may like to interact with the instructor during the examination.
- Live online Project Presentation Session on March 26, 2015 from 4:30 pm to 7:10 pm. It is compulsory for all students to participate in this session.

- Final Examination on May 07, 2015, from 4:30 pm to 6:30 pm. This live session is optional and can be used by students who may like to interact with the instructor during the examination.

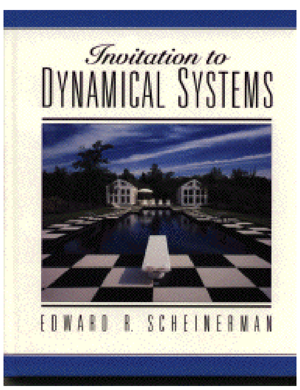
Other Course Policies

- There are no provisions for late submission of work and/or make-up examinations.
- In case of an emergency that prevents a student from submitting required work before the deadlines or taking an examination, the student must inform the instructor at the earliest via email or telephone. Such situations will be addressed on a case by case basis. (Instructor's contact information)
- No points will be awarded if homework is turned in after solutions have been posted.
- Religious observances are one common example of events that might impact students' activities. Students are responsible for planning ahead. Please, refer to the GMU's calendar of religious holidays.
- All academic policies as given in the Honor System and code will be strictly followed. These are available here.
- The GMU's student privacy policy is in place for this course. It is available here.
- All general policies defined in the University Catalog are in place for this course. These are available here.
- George Mason University is an Honor Code university. See the Office of Academic Integrity website for a full description of thehonor code and the honor committee process.

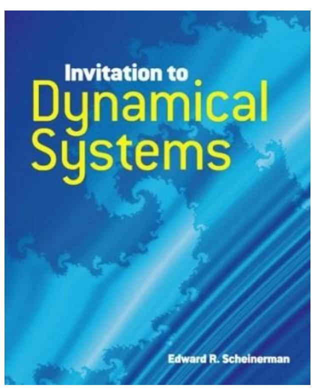
Reading and Reference Materials

A. Required Text

1. Invitation to Dynamical Systems Edward R. Scheinerman

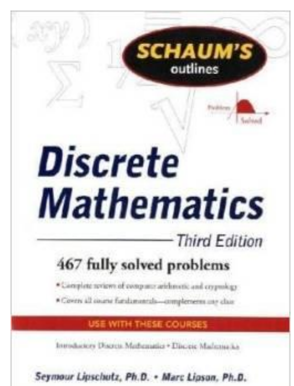


or



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

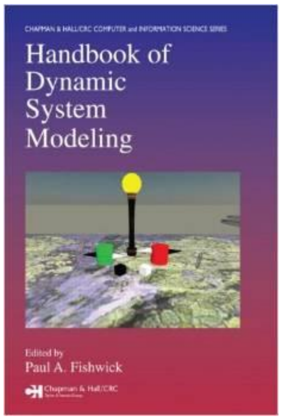


Strongly recommended for review of Discrete Mathematics' concepts

B. Recommended Text

Handbook of Dynamic Systems ModelingPaul A. Fishwick

Recommended as a reference handbook
Chapman & Hall/CRC Computer & Information Science Series
Publication Date: June 1, 2007 | ISBN-10:1584885653 | ISBN-13: 978-1584885658 | Edition: 1



C. Additional Materials

Handouts/Lecture notes and all supplementary material are included in each weekly module.

Technical Help for Blackboard & Online Tools

- For Supported Web browsers (see Blackboard Support)
- Log into Blackboard Courses (use http://mymason.gmu.edu , select the Courses Tab)
- Frequently Asked Questions (see Blackboard Student Support)
- For all technical issues regarding Blackboard, see Courses Support, Blackboard Help, and Blackboard Tutorials.
- If you still have questions, complete the Courses Support Contact Us Form for assistance with Blackboard.
- For technical questions regarding computer networking, see IT Services for Students. If you still have questions, email support@gmu.edu or call (703) 993-8870.

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 • Petri Nets	3	ABSI, ATS, C4I and SMG
6.	Stochastic Systems • Decision Analysis • Markov Chains	2	C4I, SEA, SMG, and FSE

Weekly Schedule (subject to change as course progresses)

- The following table gives an overview of the entire course with important dates for examinations and presentations highlighted.
- A student needs to follow the links to the weekly modules to access all the course material including instructional videos, lecture notes, reading material, and assignments.
- The assignment submission must be done in the 'Assignment' Section before the deadline.
- Review the material in 'Examination' Section for details on making arrangements for an examination proctor.

Week	Lecture Topic(s)
Jan 20 – Jan 26	Introduction to Systems; System Taxonomy; Review of Mathematical Concepts
Jan 27 – Feb 02	Review of Mathematical Concepts; Modeling Concepts; State Machines
Feb 03 – Feb 09	Discrete-Time Systems I
Feb 10 – Feb 16	Discrete -Time Systems II; Markov Chains
Feb 17 – Feb 23	Continuous -Time Systems
February 26	**Midterm Test**
Mar 03 – Mar 09	System Dynamics I
Mar 10 – Mar 16	*Recess (No Activity)*
Mar 17 – Mar 23	System Dynamics II
Mar 24 – Mar 30	**Student Presentations**
Mar 31 - Apr 6	Formal Languages; Finite-State Automata
Apr 07 – Apr 13	Finite-State Automata Composition
Apr 14 – Apr 20	Extended State Machines; Timed Automata; DEVS
Apr 21 – Apr 27	Discrete Event Systems with Petri Nets
Apr 28 - May 04	Decision Analysis
May 07	**Final Examination**

Academic Integrity

GMU is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

Disabilities Statement

If you have a documented learning disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Office of Disability Services (SUB I, Rm. 4205; 993-2474;http://ods.gmu.edu) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

Mason Diversity Statement

George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

The reflection of Mason's commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. The implementation of this commitment to diversity and inclusion is found in all settings, including individual work units and groups, student organizations and groups, and classroom settings; it is also found with the delivery of services and activities, including, but not limited to, curriculum, teaching, events, advising, research, service, and community outreach.

Acknowledging that the attainment of diversity and inclusion are dynamic and continuous processes, and that the larger societal setting has an evolving socio-cultural understanding of diversity and inclusion, Mason seeks to continuously improve its environment. To this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.

Student Support Resources on Campus

Resources that you may find helpful may be found at:

http://ctfe.gmu.edu/teaching/student-support-resources-on-campus/