CSE-561
Modeling & Simulation Theory and Application
Fall 2014

General: Building/Classroom: Bateman Physical Sciences Center A, Tempe campus
Lecture Days & Hours: Mon. & Wed.; 3:00 – 4:15 PM
Course Portal: https://my.asu.edu (SLN: 88579)

Instructor Hessam S. Sarjoughian
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Bldg/Room: BY/476
URL: http://acims.asu.edu/
Office hours: Tues. & Thur. 12:45 – 1:45 PM; and by appointment

Textbooks
- *Theory of Modeling & Simulation*, 2nd Ed., B.P. Zeigler, H. Praehofer, T.G. Kim, 2000
- *Introduction to DEVS Modeling & Simulation with JAVA: Developing Component-based Simulation Models*, B.P. Zeigler and H.S. Sarjoughian (available from Blackboard)

References
- *System Design, Modeling, and Simulation using Ptolemy II, C. Ptolemeaeus, Editor, 2014, http://ptolemy.eecs.berkeley.edu/books/Systems/*
- *Guide to Modeling and Simulation of Systems of Systems, B.P. Zeigler, H.S. Sarjoughian, 2013*
- *Parallel and Distributed Simulation Systems*, R.M. Fujimoto, 2000
- *Simulation Modeling and Analysis*, 3rd Edition, A. Law and W. Kelton, 1999
- *Simulation Model Design and Execution: Building Digital Worlds*, P. Fishwick, 1995
- *Model-Based Systems Engineering: an introduction to the mathematical theory of discrete systems and to the tricotyledon theory of system design*, W. Wymore, 1993

Software DEVS-Suite Simulator (http://devs-suitesim.sourceforge.net/), CoSMoS Modeler (http://cosmosim.sourceforge.net/), and Eclipse (http://www.eclipse.org/) IDE will be used for simulation model development.

Prerequisite:
To enroll in this course, graduate standing in Science or Engineering degree programs (e.g., Computer Science, Electrical Engineering, Industrial Engineering, Mechanical Engineering, or Physics) is required. Maturity in Java or another high-level computer programming language is assumed. Prior object-orientation modeling experience is helpful, although not assumed.

Course Objectives:
Present concepts of computer-based modeling and simulation applicable to various domains of engineering and science. Provide theoretical concepts, methods, and hands-on experience with object-oriented modeling and simulation. Students are expected to gain a solid foundation and associated experience for computer-based tool set for constructing, simulating and analyzing models of complex systems.

Course Description:
The course covers modeling and simulation concepts and discrete-event in particular. Application of theories, methods, and practices are covered during the semester. The course materials are divided into three parts. The first part covers background on systems modeling concepts and overview of object-oriented programming modeling languages. The second part covers systems modeling concepts and methods. This part contains comprehensive descriptions on how to formulate and execute (simulate) models in a software engineering-like lifecycle process. Students are engaged in detailed study of modeling elements, simulation protocols, and their relationships including experimentation. In-class description of modeling and simulation techniques will be illustrated by examples developed in the DEVS-Suite and CoSMoS (Component-based System Modeling and Simulation) tools. During the semester students will gain hands-on experience (via homework assignments and project). Students will create increasingly more complex models, which can be subsequently simulated and analyzed. The third part

focuses on selected advanced topics aiding individual and team members' projects. An important part of the course experience is through the class project. Projects involve demonstrating the application of course concepts, theories, and techniques (see the Project section below) to areas of interest to the students. Projects may focus on M&S methodologies and theories.

Homework Assignments/Exams:
There will be 3-5 homework assignments. Homework assignments include conceptualizations, model formulations, simulations, etc. Late homework will be accepted only in exceptional circumstances which need to be discussed with the instructor for approval and as long as the solution is not discussed or made available. The lowest homework assignment grade will not be included in course grade. Use standard size paper and include your name and homework assignment number at the top or on the cover page. Texts in submissions must be typed. Midterm exam will be based on the course materials – i.e., lectures, homework assignments, and readings. Final exam is comprehensive. See table below for details.

Assessment	% final grade	Date/Time
Homework	**20%**	Included in the assignments
Midterm Exam	**25%**	Oct. 23, 3:00 – 4:15 PM
Final Exam	**25%**	Wednesday, December 10; 12:10 - 2:00 PM
Project	**30%**	See below

Project:
Early in the semester, students will consult with the instructor to determine a project topic that benefits from their overall academic objectives or current professional activities (see table below for due dates). Possible modeling and simulation domains are numerous including *enterprise engineering, software engineering, computer and social networks, embedded devices, computer networks, artificial or ecological agents, and system biology*. Projects should be carried out as two-member teams. Projects can focus on students' interest including research topics.

	Preliminary Project (due date, % Final Grade)	Presentation (due date, **%** Final Grad)	Final Project (due date, % Final Grad)	Presentation & Demonstration (due date, % Final Grad)
Project	TBD, **25%**	TBD, **5%**	Dec. 8, **60%**	TBD, **10%**

Final project report grading:
Introduction and problem description: **10%**
Analysis and simulation model formulation: **30%**
Simulation models and experiments: **40%**
Results and analysis: **15%**
Conclusions: **5%**

Grading Policy and Grade Distribution:
Students are responsible for all the material covered and discussed during lectures as well as any announcements made via email or other means. Examinations may not be taken separately except in special situations with prior arrangement made **at least one week in advance**. Participation is an essential part of the course and highly encouraged. Grade distributed is

	Homework	Exams	Project
Course Grade	20%	50%	30%

% total score	≥97	≥90	≥87	≥80	≥75	≥70	≥60	<60
Letter grade	A+	A	B+	B	C+	C	D	E
Points for GPA	4.33	4.00	3.33	3.00	2.33	2.00	1.00	0.00

Academic Integrity and Ethics:
All instances of alleged cheating will be handled by the Dean's office according to the Student Code of Conduct and Student Disciplinary Procedures and STA 104-01. This university policy will be applied to all work submitted for grade, including homework assignments, quizzes, exams, reports, presentations, and software development. **Note:** you are encouraged to discuss class assignments and other activities with your instructor and fellow students. However, all work submitted as part of course work must be your own. I.e., final work submitted by student must represent his/her own individual or team efforts unless stated otherwise by the instructor.

Holidays

Labor Day Holiday	September 1
Fall Break	October 11 – 14
Veterans Day	November 11
Thanksgiving	November 27 – 28
Last day of classes	December 5

Withdrawals

Note that students wishing to drop the course AT ANY TIME must take appropriate actions according to University policy and guidelines. **Ceasing attendance does not automatically drop you from the course**.

University 21st Day	September 10
Course Withdrawal Deadline - In Person & Online	November 5
Complete Session Withdrawal	December 5
Study Days	December 6 – 7
Academic Status Report #1	September 29 – October 7
Academic Status Report #2	October 27 – November 3

Topics*:

Part I: Introduction

- Course overview
- Modeling and simulation concepts, application domains, and tools

Part II: Model development, simulation execution, and experimentation

- Fundamental simulation modeling concepts and frameworks
- System-theoretic model development principles and methods
- Component-based simulation and modeling tools
- Simulation protocol concepts, designs, and implementations
- Simulation experimentation and analysis
- Network system simulation modeling
- Multi-resolution, multi-aspect modeling
- Parallel simulation modeling concepts and methods

Part III: Heterogeneous modeling and verification & validation

- Simulation model verification and validation
- Model composability and simulation interoperability

* Topics will be covered as time permits