Introduction to Computation, Modeling and Simulation
Syllabus

Course Description:

The course will introduce the basic concepts of computation through modeling and simulation that are increasingly being used by architects, planners, and engineers to shorten design cycles, innovate new products, and evaluate designs and simulate the impacts of alternative approaches. Students will use MATLAB to explore a range of programming and modeling concepts while acquiring those skills. They will then undertake a final project that analyzes one of a variety of scientific problems by designing a representative model, implementing the model, completing a verification and validation process of the model, reporting on the model in oral and written form, and changing the model to reflect corrections, improvements and enhancements.

Required Materials:

Information will be presented online through recorded lectures and readings. Students will be required to purchase the student version of MATLAB and complete programming and modeling assignments. Online, live, webinar sessions with desktop sharing will be used to assist students with course and assignment questions. Students will need a relatively recent model personal computer, a headset and microphone, and a broadband Internet connection to participate in those sessions.

The student version of MATLAB can be purchased online directly from MathWorks
http://www.mathworks.com/academia/student_version/details.html

To get started on the class, please do the following:

1. Purchase and install MATLAB
2. Purchase a headset with a microphone if you do not have one
3. Test your computer with respect to connecting via Adobe connect at
   http://carmenconnect.osu.edu/common/help/en/support/meeting_test.htm

Course Materials

The course materials are available online at this site:

http://rrscs.oln.org/

You will receive an email with an enrollment key that allows you into the course. There you will find all of the course materials including course documents, video lectures, assignments, quizzes, and other instructions. You should begin by going through the materials for the first week of the class.

We will also be meeting with you during live, synchronous office hours. There is a poll on the class site that will help us to find a mutually convenient time for those meetings. The meetings will use Adobe Connect to allow us to share audio and computer desktops. You will receive separate instructions on how to download the Adobe client and login to those sessions.

Course Objectives:

- Demonstrate basic programming skills – functions, arrays, loops, conditional statements, procedures
- Demonstrate technical communication skills:
  Create a comprehensive report and an oral presentation with accurate visual representations of a model and its results.
- Explain the Role of Modeling:
  Discuss the importance of modeling to science and engineering, the history and need for modeling, the cost effectiveness of modeling, the time-effect of modeling, define the terms associated with modeling to science and engineering, list questions that would check/validate model results, describe future trends and issues in science and engineering, and identify specific industry related examples of modeling in science and engineering.
- Utilize the Modeling Process to identify the key parameters of a model, estimate model outcomes, utilize a computational tool, e.g., Matlab to implement the mathematical representation of the model, convey the results of the simulation accurately, validate the model with data, and discuss the quality and sources of errors in the model.
- Construct difference-based computer models
- Explain and conduct the transforming of continuous functions and dynamics equations into discrete computer representations. Write pseudo-code for finite difference modeling equations and create a simulation in a computational tool, e.g., Matlab.
- Examine mathematical representations of functions - Describe and utilize linear and nonlinear functions to model empirical data. Visualize empirical data and the fitting function using a computational tool.
- Utilize Matlab as a computational tool - Describe the system syntax, define elementary representations, functions, etc. Explain programming and the scripting process, e.g., relational operations, logical representations, condition statements, loops, etc. Create tabular and graphical results.
- Analyze modeling and simulation - Identify different types of models and simulations, describe the iterative development process of a model, and explain the use of models and simulations for hypothesis testing and explain how models link the physical world, the virtual world and the science of prediction.
- Assess computational models - Discuss methods for reviewing models, their verification and validation. Discuss the differences between the predictions of the model, the actual results and the relevance of these differences to the problem. Discuss the suitability and limits of the model to address the problem for which the model was designed.
- Complete a capstone modeling project that identifies a problem, develops a mathematical representation and transforms it to a computational model. Document the development and implementation of the model and present in oral and written form.

Topic Outline

Topic	Assignments Due	Assignments
Introduction to Modeling		Introduce yourself discussion forum
Modeling Concepts and Definitions	1/27	Review of computational science examples Discussion forum
Introduction to MATLAB	2/3	
MATLAB Scripts	2/3	MATLAB Quiz Office hours test meeting
MATLAB Arrays	2/3	Arrays assignment
Linear models	2/10	Traffic model program and report
Graphing data in MATLAB	2/10	Graphing homework
MATLAB Array Math	2/17	MATLAB Array homework
Advanced graphing in MATLAB	2/17	Advanced graphing homework
Nonlinear Functions	2/24	Quadratic program model
Nonlinear modeling examples	2/24	Unconstrained and constrained growth models
Curve fitting	3/3	Curve fitting homework
MATLAB programming assignments	3/3	Programming assignment
MATLAB I/O	3/10	Programming assignment
Stochastic models	3/31	Hiker simulation homework
Final project overview and Requirements	4/7	Choose final project
Accuracy and precision in modeling	4/14	Accuracy homework
MATLAB conditional statements	4/14	Programming assignment
Project plan	4/21	Project outline
MATLAB loops	4/21	Programming assignment
MATLAB functions	4/28	Programming assignment
Verification and validation	5/5	Modeling terminology quiz
Project implementation	5/15	Final report
Final Project Presentations	5/15	Final presentation