Introduction to Modeling and Simulation

CSE 2021

Credit Hours:
3.00

Course Coordinator:

Course Length:
14 weeks (autumn or spring)
12 weeks (summer only)

Representative Textbooks and Other Course Materials:

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Computational Science: Modeling and Simulation for the Sciences</td>
<td>Angela B. Shiflet and George W. Shiflet</td>
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Course Description:
Concepts of modeling and simulation; develop MATLAB skills to explore modeling concepts; project: design, implementation, verification/validation of model; oral and written project report.

Prerequisites and Co-requisites:
Prereq: Math 1151 (152) or equivalent, and Physics 1250 (131).

Designation:
Elective
Course Goals / Objectives:
Be competent with discussing the importance of modeling to science and engineering, the history and need for modeling, the cost effectiveness of modeling, the time-effect of modeling;
Be familiar with defining modeling terms, listing questions that would check/validate model results, describing future trends and issues in science and engineering, and identifying specific examples of modeling in science and engineering;
Be familiar with utilizing the Modeling Process to identify key parameters of a model, estimating model outcomes, and utilizing MATLAB to implement the mathematical representation of the model;
Be familiar with constructing difference-based computer models, conducting and explaining the transformation of continuous functions and dynamics equations into discrete computer representations;
Be competent with writing simple MATLAB programs performing numerical calculations as needed for modeling and simulation; be competent with implementing finite difference modeling equations and creating simulations in MATLAB;
Be familiar with visualizing empirical data and the fitting function using MATLAB;
Be familiar with identifying different types of models and simulations; describing iterative development of a model; explaining use of models & simulations for hypothesis testing;
Be familiar with discussing methods for reviewing models, their verification and validation; differences between predictions of model, actual results and relevance of these differences to the problem; suitability/limits of model;
Be familiar with documenting the development and implementation of a model and presenting it in oral and written form.

ABET-CAC Criterion 3 Outcomes:

<table>
<thead>
<tr>
<th>Significant contribution (7+ hours)</th>
<th>1</th>
<th>Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.</th>
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</thead>
<tbody>
<tr>
<td>Significant contribution (7+ hours)</td>
<td>2</td>
<td>Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program’s discipline.</td>
</tr>
<tr>
<td>Substantial contribution (3-6 hours)</td>
<td>3</td>
<td>Communicate effectively in a variety of professional contexts.</td>
</tr>
<tr>
<td>Some contribution (1-2 hours)</td>
<td>4</td>
<td>Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles</td>
</tr>
<tr>
<td>Substantial contribution (3-6 hours)</td>
<td>6</td>
<td>Apply computer science theory and software development fundamentals to produce computing-based solutions.</td>
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### ABET-EAC Criterion 3 Outcomes:

<table>
<thead>
<tr>
<th>Contribution Level</th>
<th>Outcome</th>
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</thead>
<tbody>
<tr>
<td>Significant contribution (7+ hours)</td>
<td>1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics</td>
</tr>
<tr>
<td>Significant contribution (7+ hours)</td>
<td>2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors</td>
</tr>
<tr>
<td>Substantial contribution (3-6 hours)</td>
<td>3. an ability to communicate effectively with a range of audiences - pre-2019 EAC SLO (g)</td>
</tr>
<tr>
<td>Some contribution (1-2 hours)</td>
<td>4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts</td>
</tr>
<tr>
<td>Substantial contribution (3-6 hours)</td>
<td>6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions</td>
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<tr>
<td>Some contribution (1-2 hours)</td>
<td>7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies</td>
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## Course Topics:

- Introduction to modeling; modeling concepts and definitions
- Introduction to MATLAB, scripts
- MATLAB arrays, array math
- MATLAB programming mechanisms (conditionals, loops, etc.)
- MATLAB i/o
- Advanced graphing in MATLAB; curve fitting
- Linear models
- Nonlinear functions; modeling examples
- Stochastic models
- Final project overview and Requirements
- Accuracy and precision in modeling; verification and validation; project plan
- Project implementation; Project presentations
- Review/exams