Fall 2019

IE 621-101: Simulation Modeling and Analysis

Golgen Bengu

Follow this and additional works at: https://digitalcommons.njit.edu/mie-syllabi

Recommended Citation

This Syllabus is brought to you for free and open access by the NJIT Syllabi at Digital Commons @ NJIT. It has been accepted for inclusion in Mechanical and Industrial Engineering Syllabi by an authorized administrator of Digital Commons @ NJIT. For more information, please contact digitalcommons@njit.edu.
IE 621 Simulation Modeling and Analysis

3 credits, 3 contact hours (3;0;0).

Instructor Information

Instructor: Prof. Bengu
E-mail: bengu@njit.edu
Office Hours: Before and after classes and others by appointment ME322
             R 5:05pm – 5:55:pm or 8:55 -9:15 pm or by appointment

Course Identification

Course Number: IE621
Course Name: Simulation Modeling and Analysis
Course Location: ITC 2nd floor 2305
Class Times: R 6:05pm – 8:55:pm
Prerequisites: Students should have a working knowledge of Basic statistics

Course Description/Overview

This course introduces discrete event simulation modeling techniques and the system simulation fundamentals and I/O data analyses such as how to determine appropriate Input data (Goodness of fit Test) for a simulation model, and analyze the Output data of simulation experiments. Verification of the model and Validation of the simulation results are reviewed. Improving the system performance by integrating with optimization techniques such as Design of Experiments, Opt Quest, ANOVA, and Regression concepts are implemented via Course projects.

Course projects must contain complex decisions making processes which might include consideration of physical efficiency as well as economical efficiency involving multiple objectives, with uncertainty, and risk and resource failure.

Continuous system simulation and system analysis are also introduced briefly. Students are provided hands on simulation modeling expertise using GPPL or GPSL (such as ARENA, or SIMIO or FLEXSIM, and EXCEL,) and introduced to Statistical Analysis tools such as Minitab/SAS.

Interested students are also encouraged to build high-level detailed simulation model projects and complete a technical report to present it in professional conferences. Simulation Competition & Award Opportunities are announced and those students who are interested are provided help to compete.

The fundamentals of simulation modeling and analysis concepts are introduced with emphasis on problem solving and utilizing computer tools. The class provides a comprehensive treatment of
simulation using industry-standard Arena software. The class starts by having the student develop simple high-level models, and then progresses to advanced modeling and analysis. Statistical design and analysis of simulation experiments is integrated with the modeling chapters, reflecting the importance of mathematical/statistical modeling of these activities. Upon Completion of the Semester project, the students must be able administer a simulation project successfully and build large scale, non-stationary deterministic stochastic models with medium level complexity.

Course Resources

Course Website(s)

Course Text

|--------------------------------------------|---------------------------------------------------------------|

Optional: Simulation Modeling and Arena
- By Manuel D. Rossetti (University of Arkansas)
- Pub. Date: 1/1/2009 Publisher(s): WILEY

Reference: By Banks, Carson et al, Prentice Hall Reference Books:
- [www.bcnn.net](http://www.bcnn.net)
  - (illustrates Simulation using Spread Sheet)

Software:

1. ARENA [www.arenasimulation.com](http://www.arenasimulation.com)
2. SIMIO [www.simio.com](http://www.simio.com)
3. Flexsim [www.flexsim.com](http://www.flexsim.com) (optional)
4. EXCEL ([ist.njit.edu](http://ist.njit.edu))

Minitab

SAS (optional)

MSProject

Students must install the software either from NJIT side or Internet on their computers by 2nd class & bring their computers to class.

To run ARENA on Mac
1. Install bootcamp (free) or Parallel, or VMWARE (~$50)
2. Install Win OS
3. Install ARENA
### Grading System

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Percentage</th>
<th>Grade points/credit</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93% &amp; above</td>
<td>4.00</td>
<td>Excellent</td>
</tr>
<tr>
<td>A-</td>
<td>88% – 92%</td>
<td>3.50</td>
<td>Very good</td>
</tr>
<tr>
<td>B</td>
<td>82% – 86%</td>
<td>3.00</td>
<td>Good</td>
</tr>
<tr>
<td>B-</td>
<td>76% – 81%</td>
<td>2.50</td>
<td>Above average</td>
</tr>
<tr>
<td>C</td>
<td>70% – 75%</td>
<td>2.00</td>
<td>Average</td>
</tr>
<tr>
<td>C-</td>
<td>65% – 69%</td>
<td>1.50</td>
<td>Below average</td>
</tr>
<tr>
<td>D</td>
<td>60% - 64%</td>
<td>1.00</td>
<td>Inferior</td>
</tr>
<tr>
<td>F</td>
<td>59% and below</td>
<td>0.00</td>
<td>Failure</td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
<td>Incomplete; given only when a student is unable to complete a segment of the course because of circumstances beyond the student's control. A grade of incomplete may be given only when approved in writing by the department chair or school dean.</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Conditional, with no grade points per credit; given only when the student is at fault in failing to complete a minor segment of a course, but in the judgment of the instructor does not need to repeat the course. It must be made up within the next semester in residence or the grade becomes a failure (F). A (X) grade is computed into the grade point average as a (F) grade.</td>
</tr>
</tbody>
</table>

### Grading Policy

Grades will be based on the following formula:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Homeworks (&gt; 8)</td>
<td>15%</td>
</tr>
<tr>
<td>2</td>
<td>Midterm 1 Oct 7th Monday</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>Final Exam Dec 16th Monday</td>
<td>30%</td>
</tr>
<tr>
<td>4</td>
<td>Project Presentation Dec 9th? see registrar FE list</td>
<td>25%</td>
</tr>
<tr>
<td>5</td>
<td>Instructor Assessment: Class attendance/participation Team Work &amp; Integrity</td>
<td>5%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

### Late Assignments

They will not be accepted late except for special circumstances (such as jury duty or medical problem), for which you must provide documentation.

### Collaboration/Plagiarism Rules

Specific course rules or policies regarding collaboration on graded academic exercises.

**Example:** Cell phones, Blackberries, iPods, PDAs, or any other electronic devices are not to be used in the classroom. Information exchanges on these devices during class are also prohibited and violate the Academic Integrity Code of New Jersey Institute of Technology.

**NJIT Honor Code will be upheld, and that any violations will be brought to the immediate attention of the Dean of Students**
<table>
<thead>
<tr>
<th>Lecture</th>
<th>Objective</th>
</tr>
</thead>
</table>
| no      | INTRO TO SIMULATION MODELING  
Understanding the role of simulation in systems analysis such as manufacturing and service systems.  
Assg: Study 2 Arena Examples, Report Results after reading Articles  
Examples:  
- Flexible Manufacturing System, Transportation System  
- Health Care System – ER room, Bank Model System |
| 1       | INTRO TO COMMON APPLICATIONS OF SYSTEM SIMULATION EXPERIMENTS  
Presenting simulation results using a confidence level approach. Syllabus Review, Example: Airport Inspection/Mortgage Application Simulation Model  
Assg: Build Airport Inspection Analyze 3 Replication Results with 95% CI, Recommend  
*Check Last day to drop full semester courses with a refund |
| 2       | Arena- MODELING  
Arena Basic Modules: Arrive, Server, Depart, Simulate and fundamental concepts of numerical computation  
Assg: Report Basic Modules/Elements  
*Check Last day to drop full semester courses w/h a grade on record - No Refund |
| 3       | Discrete Event Simulation  
Assg: Electronic Assembly System Model |
| 4       | Fundamental Concepts in Simulation  
Event Scheduling- Time Advance, Manual Simulation  
Assg: Manual Simulation viaExcel |
| 5       | Midterm Exam |
| 6       | Continuous System Simulations and System ANALYSIS  
Queuing Systems. Inventory Systems,  
Examples (Banks, Warehouse, FMS)  
Assg: Ch5 Call Center system & Inventory Model |
| 7       | Simulation of Simple/Advanced Manufacturing Systems with Material Handling  
Assg: Model Sequenced Jobs on an FMS system with Transporters  
Check Last day to drop full semester courses with a grade of 'W' |
| 8       | Statistical Models in Simulation  
Discrete, Continuous Distributions - EXAM |
| 9       | Simulation of Advanced Systems, Random Number Generation  
EXAM Review |
| 10      | Random Variant Generation  
Exponential, Uniform, Acceptance Rejection Techniques  
EXAM Review |
| 11      | Simulation of Manufacturing Transportation Systems, Input Modeling  
Input Distribution, Q-Q Plots, Parameter Estimation, Goodness of Fit Tests: K-S, Chi-Square  
Assg: Goodness of Fit Tests |
| 12      | Verification and Validation  
Calibration, Face Validity, Turing Test  
Assg: Literature Review on Verification/Validation |
| 13      | Output Analysis: Confidence Intervals, variance reduction.  
Confidence Intervals, Replication, Batch Means  
Project |
| 14-16   | Comparison and Evaluation of Alternative Systems |
Independent Sampling, CRN, Bonferroni Approach to Multiple Comparisons, Linear Regression, DOX Design of Experiments, Optimization via Simulation

Final Exam & Project

(Based on the class progress deviations in schedule may occur- consult with instructor)

University Policies

Academic regulations and procedures are governed by University policy. Academic dishonesty cases will be handled in accordance the University's policies.

If you have a disability that could affect your performance in this class or that requires an accommodation under the Americans with Disabilities Act, please see me as soon as possible so that we can make appropriate arrangements. The Affirmative Action Office has asked that you be made aware of the following:

New Jersey Institute of Technology complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disabilities Act of 1990. If you have a disability and need a reasonable accommodation for equal access to education or services at New Jersey Institute of Technology, please call the Dean of Students Office, at 973-596-3470. For other concerns about discrimination, you may contact Computer Science Department Chair at 973-596-5488.

Academic Integrity:

Every student should read the University Code on Academic Integrity (http://www.njit.edu/academics/integrity.php). All work that you represent as your own must, in fact, be your own. Work done by others must be given proper credit.

Course Policies

1. **Attendance is mandatory.** A student who misses > 5 classes will be dropped, without credit. Getting to class late or leaving early counts as half an absence.
2. **You must review the textbook for HW.** The text illustrates examples and homework that will be done in the class.
3. **Homework and projects** must be submitted in hard copy or e-copy (as instructed) at the beginning of class on the due date. They will not be accepted late except for special circumstances (such as jury duty or medical problem), for which you must provide documentation. Semester project will consist of a written and oral presentation. All submitted work (including exams) must include your name and student ID.
4. **Plagiarism** will result in zero credit for the assignment and/or an F grade in the course.
5. **Cell phones or any other electronic devices** must be turned off during class and are not permitted during exams (exceptions: approved computers use)