Fall 2023

IE 621-101: Syst Analysis & Simulatn

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NJIT

New Jersey Institute of Technology M&IE – Course Syllabus

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:	After classes and others by appointment (ME322), and WebEx, Zoom,GoogleMeet

Course Identification

Course Number:	IE621
Course Name:	**Simulation Modeling and Analysis**
Course Location:	Webex, *(ITC 2305/ 2315A if class is over capacity)*
Class Times:	M 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

Course projects are chosen from complex stochastic systems. These simulated models are commonly used in decision-making processes which might include physical efficiency as well as economical efficiency concepts and or multiple objectives, with uncertainty, and risk and resource failure.

Continuous system simulation and system analysis examples 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)

- Canvas<http://canvas.njit.edu> *for course management/communication and discussions.*

Course Text

	• *Required* **Simulation with Arena 7th edition** ***by Kelton, W. David, Zupick, Nancy****, Ivey, Nathan* Print ISBN 9781264162444, 1264162448 • E Text ISBN 9781265886196, 1265886199
	*Optional:* Simulation Modeling and Arena By Manuel D. Rossetti (University of Arkansas) Edition: 1, ISBN13:9780470097267 ISBN10:0470097264 Pub. Date: 1/1/2009 Publisher(s): WILEY
	Reference: By Banks, Carson et al, Prentice Hall *Reference Books:* www.bcnn.net Discrete Event System Simulation ISBN: 0-13-144679-7 ***(illustrates Simulation using Spread Sheet)***

Software:

1. ARENA **www.arenasimulation.com**
2. SIMIO **www.simio.com**
3. Flexsim www.flexsim.com *(optional)*
4. EXCEL **(ist.njit.edu)**
   Minitab

Students must install ARENA software either from NJIT Canvas side (or Internet) on their computers by 2nd class & bring their computers to class. it must be the same version with comp.Lab, *otherwise your models will not run.*

To run ARENA on Mac : Virtualization:
1. Install bootcamp or Virtualbox (free)
2. Install Win OS &3. Install ARENA or use
1)Parallels Desktop, it also installs Windows (fee), or
2) VMware Fusion *(with a free version of VMware Fusion Player)*, or
3) VirtualBox, and UTM with a fee.

Grading System

Letter Grade	*Percentage*	*Grade points/credit*	*Rating*
A	93% & above	4.00	Excellent
B+	88% – 92%	3.50	Very good
B	82% – 86%	3.00	Good
B-	76% – 81%	2.50	Above average
C	70% – 75%	2.00	Average
C-	65% – 69%	1.50	Below average
D	60% - 64%	1.00	Inferior
F	59% and below	0.00	Failure
I	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.		
X	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.		

Grading Policy:

Grades follows the formula below:

1. Homeworks (> 8)	15%
2. Midterm 1	25%
3. Final Exam	30%
4. **Project Presentation**	25%
5. Instructor Assessment: Class attendance /participation 6. Teamwork & Integrity	5%
Total	**100%**

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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 to the dos@njit.edu and submit their approval to the instructor.

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 Academi c 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

Lecture no	Objective
1	**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*
2	**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***
3	**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***
4	**Discrete Event Simulation** ***Assg: Electronic Assembly System Model***
5	**Fundamental Concepts in Simulation** Event Scheduling- Time Advance, Manual Simulation ***Assg: Manual Simulation viaExcel***
6	Midterm Exam
7	**Continuous System Simulations and System ANALYSIS** Queuing Systems. Inventory Systems, Examples (Banks, Warehouse, FMS) ***Assg: Ch5 Call Center system & Inventory Model***
8	**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'**
9	**Statistical Models in Simulation** Discrete, Continuous Distributions – *EXAM*
10	**Simulation of Advanced Systems , Random Number Generation** ***EXAM Review***
11	**Random Variant Generation** Exponential, Uniform, Acceptance Rejection Techniques ***EXAM Review***
12	**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***
13	**Verification and Validation** Calibration, Face Validity, Turing Test ***Assg:*** **Literature Review on Verification/Validation**
14	**Output Analysis: Confidence Intervals, variance reduction.** Confidence Intervals, Replication, Batch Means ***Project***
15-16	**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. *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.*** Both the the text and slides 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)***