IEE 3300: Simulation Modeling and Analysis

Catalog Description: Use of computer modeling and discrete event simulation methodology with emphasis on designing and analyzing manufacturing and service systems. Commercial simulation packages will be used. Prerequisite: IEE 2060 & IEE 2620.

Credit/Contact Hrs: This is a 3 credit hour required course in the IEE Program and is scheduled for 3 contact hours per week.

Course Coordinator and Instructor: Dr. Azim Houshyar

Textbook:

1. Simulation using ProModel; Harrell, Ghosh and Bowden; McGraw Hill;
2. Notes on Simulation Modeling using ProModel; Houshyar.

Software: *ProModel* from ProModel Corporation, Orem, Utah; https://www.promodel.com/Products/ProModel

Computer Usage:

Extensive use of computer software is required throughout this course. Students are encouraged to solve problems on statistical analysis manually, and then reconfirm their results using computer.

Evaluation:

1st exam	**25 pts**
2nd exam	**25**
Term-project	**20**
Quiz	**20**
Homework	**5**
Active Participation	**5**
Total Score	***100 pts***

Grading Scale:				
	93 - 100	**A**	**88 - 92**	**BA**
	83 - 87	**B**	**78 - 82**	**CB**
	73 - 77	**C**	**68 - 72**	**DC**
	60 - 67	**D**	**Below 60**	**E**

Course Learning Objectives: By the end of semester the student should be able to:

1. Apply knowledge of mathematics and engineering to discrete-event simulation problems
2. Numerically analyze and solve all discrete-event simulation problems
3. Report and present individual and group results.

Performance Criteria (Learning Outcomes): The student should be able to:

Course Objective 1

a) Provide accurate description to the discrete-event simulation questions.
b) Determine the appropriate solution technique to solve real-world simulation problems.

Course Objective 2

a) Provide accurate description to the random number generation, input modeling, output analysis, and comparison of alternative system designs questions.
b) Determine the appropriate simulation model to solve any real-world problems.

Course Objective 3

a) Participate in teamwork, class discussion, case studies, and submit written and oral reports to the class.

Relationship of Course Objectives to Performance Criteria and Student Learning Outcomes:

Course Objectives	Performance Criteria[1]
Apply knowledge of mathematics and engineering to discrete-event simulation problems.	**B2**. Uses experiments and their results to improve a process.
Numerically analyze and solve all discrete-event simulation problems	**K3**. Applies systems tools (LP, MSM) to model and solve problems.
Report and present individual and group results.	**D2**. Researches and gathers information for team project.

Academic Honesty Policy:

The Faculty Senate's Professional Concerns Committee recommends all instructors include the following paragraph in each syllabus they prepare.

"You are responsible for making yourself aware of and understanding the policies and procedures in the Undergraduate and Graduate Catalogs that pertain to Academic Honesty. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. [The policies can be found at http://catalog.wmich.edu under Academic Policies, Student Rights and Responsibilities.] If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Conduct. You will be given the opportunity to review the charge(s). If you believe you are not responsible, you will have the opportunity for a hearing. You should consult with your instructor if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test."

In addition, instructors are encouraged to direct students to http://osc.wmich.edu and www.wmich.edu/registrar to access the Code of Honor and general academic policies on such issues as diversity, religious observance, student disabilities, etc.

Attendance Policy:

Attendance is **not** mandatory. But, student will receive a score of zero for any assessment item not submitted because of absence -this includes the assignments, project reports, test, and the final exam. Extreme circumstances will be considered on an individual basis, however, when possible arrangements must be made prior to the due date, and supporting documentation is necessary. Moreover, you are expected to actively participate in the discussion. Please note that you will be graded on your participation, so don't keep quiet!

Expectation during lecture:

- You ARE expected to be in class before it starts. No late arrival will be tolerated.
- The class is being held in the computer lab, so we can use computer software to solve problems. You MAY NOT use the computer to read your e-mails, news, etc.
- You MAY NOT ask questions from your fellow students. However, you are encouraged to ask any questions from the instructor.
- You MUST turn your cells phones off.

Homework:

Recommended homework problems will be given in class. These problems are recommended and will be collected when announced in class. At the end of semester, I will ask for your homework note-book, and will review them for completeness. Your grade for active participation will be affected by incomplete assignment submission. At times, I may choose to grade only a few of the submitted homework (i.e., you submit your solution to ten problems, and I only grade one of those ten problems). In such case, your grade will be based on the ones that I actually grade. You are encouraged to work these problems to help you learn the material.

You are welcome to solve any problem using software, unless I have specified otherwise. If you use software to solve a problem you must submit sufficient documentation to illustrate your approach to the problem, along with the appropriate output to justify your results.

Quiz/Exam:

Starting with the second week, every week there will be an unannounced 10-20-minute quiz on the subject matter covered in the previous sessions. Therefore, you are responsible for the material up to the day of the quiz. During each quiz you are allowed to have a calculator, but no cell phones or laptops are allowed.

Notes:

1. The lectures will focus on the main topics, but students are responsible for reading the whole chapter.
2. The style of teaching is based on the notion of *Critical Thinking*. As such, students are expected to review the chapter prior to coming to class. In doing so, the class time will be dedicated to answering questions and solving problems. Rather than an elaborate lecture plan, a brief review of the main topics will be conducted in class, but you should study them in detail, and ask questions, if necessary.

Term-Project: Group Projects using ProModel

Students are teamed-up in-groups of three. Each team is expected to identify a real-world manufacturing/ industrial/financial/service problem to be simulated. The grade is based on the complexity of the problem, the elegance of the simulation model, and the quality of the presentation.

Each team is free to choose any problem, but they are expected to adhere to this guideline. The simulation problem should include:

1. A minimum of ten ***Locations*** with at least ten ***Processing Stations***
2. A minimum of five ***Random Processing Times***
3. A minimum of five ***Resources***
4. A minimum of three ***Attributes***
5. A minimum of three locations and resources ***Downtimes***
6. ***Shift*** assignments to locations and resources
7. ***Path Network*** for the material handlers, resources and entity movements
8. ***Counters*** that show the number of processed part in each station, throughput, and a summary of major statistics.
9. Appropriate use of ***Macros***, ***Subroutines***, ***Table Functions***, ***User Distributions***, ***Arrival Cycles***, ...

Each team should submit five reports during the course of the semester along with a disk-copy of the simulation model and supporting material. The proposed due dates are selected so that you will not be overwhelmed with submitting a comprehensive report for the whole project at the end of semester.

The nature of the reports and the corresponding due dates for these reports are as follows:

1.	***Report 1: Proposal/Problem Definition***	***Due January 30***
2.	***Report 2: Data Collection/Processing Report***	***Due February 30***
3.	***Report 3: Building the Simulation Model***	***Due March 20***
4.	***Report 4: Validation and Verification Report***	***Due April 10***
5.	***Report 5: Final Report: Project Finding***	***Due April 17***
6.	***Final PowerPoint Presentation by the Team***	***Due April 20-24***

First Report: Consists of description of the problems, clear statement of how you propose to solve it, clear statement of the objective/s to be measured for the current system and compared with the proposed system, the number of entities, the number of locations, the number of resources, the flow of material, the flow of personnel, flow chart, operational logics, ..., the data that is needed to be collected (for this report just name them, you will collect them in the next report). At a minimum, the First Report should include:

- One page description of the problem
- A clear statement of the goal of project
- A very clear and detailed flow chart of the current process showing how the entities move through the system
- A complete list of the components of the model
- A list of decision variables (factors) that you are going to experiment with
- Description of the types of data to be collected or has been collected in a previous course.

Second Report: Consists of Data Collection and Data processing. In this report, all the data, whether they are for arrival, operations, logics, or downtimes has to be collected and statistically processed. At a minimum, the Second Report should include:

- All the collected data in the original raw form, categorized into
  - Operational Data
  - Structural Data
  - Logical Data
- A clear explanation of the methodology used to process the raw data
- A comprehensive detail of the processed data (fitted distributions), along with the corresponding charts and graphs.

Third Report: This report is mainly details of the ProModel that you have constructed to represent the current situation. The ProModel *should be as comprehensive as possible and as close to your final model as possible*. Don't worry about validation or verification. That will be done in the next report. At a minimum, the Third Report should include:

- A Disk containing the most up-to-date simulation model that reasonably depicts the real-world problem, and is error-free (can run!!!).
- A detailed documentation of all the logics that were used in your simulation model. The documentation should be detailed enough that any one reading it can understand your model.

Fourth Report: This report will show the verification and validation efforts that were used to prove that the ProModel represents the real world problem. You must show that your Model output is statistically the same as the real-world output. For this purpose, you have to run simulation numerous times, and find the mean and standard deviation of the objective(s) of interest. Then use statistical test to compare that with the real-world distribution and show that they are statistically indifferent.

You have to, also, list all tools that you used for verification, and explain each one. For instance, you used animation to correct the way resource is modeled. In addition, you will to build Proposed Scenarios for what if analysis. Once more, it is not enough to state that you have done verification and validation, but instead, you MUST document all the iteration that you had to go through to validate and verify your model.

Fifth Report: This is your final report and shows all your simulation runs, your statistical analysis of the output, and your recommendations. It has to be submitted to me prior to your final presentation. Make sure that you have:

- Clearly elaborated on your design of experiment,
- Justified the number of simulation runs,
- Listed all your decision variables, and their corresponding levels,
- Shown your ANOVA and have properly interpreted its findings.

You are expected to submit a formal report to your industrial sponsor at the same time, and make a formal presentation. Failure to do so will adversely affects your grade.

Final Powerpoint Presentation: Each team will have 10 minutes to present their cases to the class and answer questions and concerns. The presentation should include:

1. Define the problem
2. State the goal of the simulation modeling
3. Depicts the flow of material/resources/information through the system
4. List a complete list of decision variables/factors
5. State the procedure used to collect data relevant to the problem
6. Describe the simulation model
7. Description of the experimental design procedure
8. Explain the simulation outputs
9. Discuss the team's interpretation of the output; and
10. List the team's recommendations as to how the problem can be resolved.

Use the following format for all your submissions

Us the following Type Font, Spacing, and Indent:

Title: Times New Roman 16, Bold; Leave two line-space above title for submission code

Executive Summary heading: Times New Roman 14, Bold, Italic

Executive Summary text: Times New Roman 11, Italic

Heading 1 (e.g., introduction): Times New Roman 14, Bold

Heading 2: Times New Roman 12, Bold, Italic

Heading 3: Times New Roman 11, Bold

All other text: Times New Roman 11

Use white, 8 ½ - by 11" paper. Except for page numbers (see below), leave one-inch margins all around the text of your paper -- left side, right side, and top and bottom. Paragraphs should be indented half an inch. The submission must be single-spaced.

Your submission does not need a title page. At the top of the first page, at the left-hand margin, type your Team number, names, your instructor's name, the course number, and the date -- all on separate, single-spaced lines. Then double-space and center the title above your text. (If your title requires more than one line, double-space between the lines.) Double-space again before beginning your text. The title should be neither underlined nor written in all capital letters. Capitalize only the first, last, and principal words of the title. Titles might end with a question mark or an exclamation mark if that is appropriate, but not in a period.

Number your pages consecutively throughout the submission (including the first page) in the upper right-hand corner of each page, one-half inch from the top. Type your Team # before the page number. Make sure the page-number is always an inch from the right-hand edge of the paper (flush with the right-hand margin of your text) and that there is a single-space between the page number and the top line of text. Do not use the abbreviation *p.* or any other mark before the page number.

Tables should be labeled "Table," given an Arabic numeral, and captioned (with those words flush to the left-hand margin). Other material such as photographs, images, charts, and line-drawings should be labeled "Figure" and be properly numbered and captioned.

Generally, the simpler the better. Why spend money on gimmicky, unwieldy, slippery binders, when I prefer nice, flat stacks of papers they can stuff into my briefcase. A simple staple in the upper left-hand corner of your paper should suffice.

COURSE OUTLINE

Week Number	Topic
Week 1	Chapter 1: Introduction to Modeling Simulation *Lab 1: Introduction to ProModel*
Week 2	Chapter 2: System Dynamics *Lab 2: Building Your First Mode*
Week 3	Chapter 3: Simulation Basics *Lab 3: ProModel Ouput Viewer*
Week 4	Chapter 4: Discrete-Event Simulation *Lab 4: Basic Modeling Concepts*
Week 5	Chapter 4: Discrete-Event Simulation *Lab 4: Basic Modeling Concepts*
Week 6	Chapter 5: Data Collection and Analysis *Lab 5: Fitting Statistical Distribution to Input Data*
Week 7	Chapter 5: Data Collection and Analysis *Lab 6: Intermediate Model Building*
Week 8	*Preparation for the 1st Test* ***First Test***
Week 9	Chapter 6: Model Building *Lab 6: Intermediate Model Building*
Week 10	Chapter 6: Model Building *Lab 6: Intermediate Model Building*
Week 11	Chapter 7: Model Verification and Validation *Lab 7: Model Verification and Validation*
Week 12	Chapter 8: Simulation Output Analysis *Lab 8: Simulation Output Analysis*
Week 13	Chapter 9: Comparing Systems *Lab 9: Comparing Alternative Systems*
Week 14	***Project presentations*** *Preparation for 2nd Test*
Week 15	***Second Exam***