



**Stevens Institute of Technology**  
**School of Systems and Enterprises**  
Castle Point on Hudson  
Hoboken, NJ 07030

**Fall 2023**

**EM 605**

**Elements of Operations Research**

Instructor: Ali Yassine, Ph.D.

Contact Info: 205 North Building. Email: [ayassine@stevens.edu](mailto:ayassine@stevens.edu)

Office Hours (In-person & Virtual): Mondays 5:00-6:00pm. Tuesdays 2:30-3:30pm. OR by appointment.

<https://stevens.zoom.us/my/ayassine>

Course Schedule & Classroom Location: Tuesdays 3:30PM - 6:00PM / McLean 114

Prerequisite(s): Good understanding of linear Algebra & Calculus and basic knowledge of Probability & Statistics. Please see the instructor if you are unsure of your background.

**Course Description (Overview)**

This course brings a strong modeling approach to the process of obtaining and utilizing resources to produce and deliver useful goods and services to not only meet the goals of an organization, but also to optimize the use of resources in meeting those goals. The focus will be on formulating and analyzing large-scale complex engineering systems using decision-oriented models such as Deterministic Optimization (Linear, Integer & Dynamic Programming), Decision Analysis, Markov Chains, and Queuing Theory. These models will be introduced and implemented using commercially available software.

**Student Learning Outcomes**

After successful completion of this course, student will:

- Understand the conceptual underpinnings of methods and techniques used in operations research
- Select and develop appropriate models based on theoretical standards, and judge the suitability of models based on the assessment of performance and usability
- Use available software analysis tools with ease, selecting appropriate tools for various analyses and situations.
- Summarize and present solutions in a clear, coherent, and professional manner.

**Recommended Textbooks**

- Jensen, P. and Bard, J., Operations Research Models and Methods, John Wiley & Sons, 2003.
- Hillier and Lieberman, *Introduction to Operations Research*, 10th edition, Hillier and Lieberman, McGraw-Hill, 2015.
- Taha, Hamdy S., Operations Research: An Introduction, Prentice Hall, 10<sup>th</sup> Edition or newer.

**Software**

Microsoft® Excel Software

## Grading Guidelines

The final grade for the course will be calculated using the following grading scale:

|   |             |
|---|-------------|
| Homework Assignments                    | 15%         |
| Class Participation                     | 5%          |
| Group Term Project (Proposal document)  | 5%          |
| Group Term Project (Progress Report)    | 5%          |
| Group Term Project (Final Presentation) | 5%          |
| Group Term Project (Final Report)       | 10%         |
| Midterm Exam                            | 25%         |
| Final Exam (cumulative)                 | 30%         |
| <b>Total</b>                            | <b>100%</b> |

## Attendance Policy

Students are expected to attend each class session on a regular and punctual basis to obtain the educational benefits that each meeting affords. However, there is no grade on attendance. In the event of a student's absence from a test, the instructor will generally determine whether the student will be allowed to make up the work. The privilege of taking a makeup examination is generally not extended beyond one semester from the original date of examination.

## Homework

Homework problems will be assigned almost weekly throughout the semester. The homework assignments and solutions will be posted on CANVAS on timely basis. Please check CANVAS at least once a week.

## Classroom Behavior

Behavior that disrupts, impairs, interferes with, or obstructs the orderly conduct, processes, and functions within an academic classroom or laboratory violates the student code of conduct and may result in disciplinary action. This includes interfering with the faculty member's role to carry out the normal academic or educational functions of his/her classroom or laboratory, including teaching and research.

## Academic Integrity

Each student enrolled in a course at Stevens agrees that, by taking such course, he or she consents to the submission of all required papers for textual similarity review to any commercial service engaged by Stevens to detect plagiarism. Each student also agrees that all papers submitted to any such service may be included as source documents in the service's database, solely for the purpose of detecting plagiarism of such papers.

· **Plagiarism** is the appropriation of all or part of someone else's works (such as but not limited to writing, coding, programs, images, etc.) and offering it as one's own. Cheating is using false pretenses, tricks, devices, artifices or deception to obtain credit on an examination or in a college course. If a faculty member determines that a student has committed academic dishonesty by plagiarism, cheating or in any other manner, the faculty has the academic right to 1) fail the student for the paper, assignment, project and/or exam, and/or 2) fail the student for the course and/or 3) bring the student up on disciplinary charges according to university rules and regulations.

## Term Project – Written Final Report

Discuss the potential role of Mathematical Models in a real-world problem for which you can obtain data. You must clearly define an engineering management situation that you think optimization methods can be used to bring about significant improvement. The written project reports must be computer printed. The length of the written report is strictly limited to 10 pages, but exhibits up to 5 additional pages may be appended. Each report must include the following information in this order:

- **Purpose of Model** – Motivation, project description, and problem statement or definition.
- **Literature Review** – Each team is required to include in their project report the summary and discussion of **at least two journal articles** from the INTERFACES journal (or related journals such as Management Science, European Journal of Operational Research, etc. Alternatively, you can use Google Scholar to look for relevant articles). Please confirm the article selection with me before proceeding further.
- **General Model Structure:** Model Formulation
  - Decision Variables or Decision alternatives
  - Objective(s)
  - Constraints
  - Data Sources

- **Model Solution:** You must apply optimization models to a representative data set. Use MS Excel Solver, Excel premium Solver, LINDO, GAMS, or CPLEX to run your model.
- **Sensitivity Analysis:** Perform sensitivity analysis on important input model parameters
- **Recommendations:** make recommendations based on a through sensitivity analysis of the model output.
- **Summary and Conclusion**

#### **Team Contribution**

Each team member will also email me a one-page summary (COLLEAGUE EVALUATION FORM) outlining the contributions made by him/or her and the other members of the team to the final project. I will use these summaries to determine a differential grading structure for the final project. **If you do not email this summary, you will get a ZERO on the project.** See page 5 in this syllabus for the COLLEAGUE EVALUATION FORM.

**Final Presentation Slides** – about 10 PowerPoint slides

**The below table should also work for structuring the written final report!**

|   |            |
|---|------------|
| Cover page  | 1 slide    |
| Project /company background & description – Introduction, motivation and problem statement  | 2-3 slides |
| Literature Review   | 1-2 slides |
| General Model Structure: Model Formulation <ul style="list-style-type: none"> <li>• Decision Variables or Decision alternatives</li> <li>• Objective(s)</li> <li>• Constraints</li> <li>• Data Sources</li> </ul> | 1-2 slides |
| Model Solution  | 1-2 slides |
| Sensitivity Analysis  | 1-2 slides |
| Recommendations   | 1 slide    |
| Conclusion/ Summary / Closing remarks   | 1 slide    |

#### **Grading of Group Final Presentation**

- See rubric sheet on the next page (page 4)

## Oral Presentation Scoring Rubric

The professor will use this rubric to evaluate each group's presentation.

Students can look at this rubric so they may understand what they are being graded on.

|  | <b>Score</b>  |  |   |   |
|--|---|--|---|---|
| <b>Criteria</b>  | 1 (weak)  | 2 (Adequate)   | 3 (Good)  | 4 (Excellent)   |
| <b>Content</b><br>Did the Presentation provide an appropriate level of analysis, discussion, and evaluation as required by the assignment?   | The depth of the presented analysis and evaluation is insufficient! Students <b>did not use any</b> of the material discussed in the course to support analysis | Presented material is analyzed at a reasonable level, but students <b>used only some</b> of the material discussed in the course to support their analysis | Presented material is analyzed at a reasonable level. Students <b>used many</b> of the material discussed in the course to support their project analysis | Presented material is completely analyzed and evaluated, providing support for all main points using <b>all the material</b> discussed in class, as appropriate |
| <b>Collaboration</b><br>Did everyone contribute to the presentation? Did everyone seem well-versed in the material?  | The teammates never worked from others' ideas. It seems as though only a few people worked on the presentation  | The teammates sometime worked from others' ideas. However, it seems as though certain people did not do as much work as others                             | The teammates worked from others' ideas most of the time. And it seems like every did some work, but some people are carrying the presentation            | The teammates always worked from others' ideas. It was evident that all of the group members contributed equally to the presentation                            |
| <b>Organization</b><br>Was the presentation well organized and easy to follow?   | The presentation lacked organization and had little evidence of preparation   | There were minimal signs of organization or preparation  | The presentation had organizing ideas but could have been much stronger with better preparation   | The presentation was well organized, well prepared and easy to follow   |
| <b>Slides Style &amp; Format</b><br>Presentation contains effective visual aids (e.g., PowerPoint slides) and graphics with well-chosen words / statements. number of slides is consistent with the time permitted | Ineffective use of visual aids. Too many slides that do not support the presentation objectives   | The visual aid is generally supportive of the presentation but some of them are difficult to read or too busy  | The visual aid is generally supportive of the presentation but could be improved  | The visual aids (e.g., PowerPoint slides) are informative, well-designed, easy to read / follow, complement the speakers' content, and right number of slides   |
| <b>Presentation skills</b><br>Did the presenters Speak clearly? Did the engage the audience? Was it obvious the material had been rehearsed?   | Presenters were unconfident and demonstrated little evidence of planning prior to presentation  | Presenters were not consistent with the level of confidence/ preparedness they showed the classroom but had some strong moments                            | Presenters were occasionally confident with their presentation however the presentation was not as engaging as it could have been for the class           | Presenters were all very confident in delivery and they did an excellent job of engaging the class. Preparation is very evident                                 |
| <b>Conclusion</b><br>The presentation is expected to draw appropriate conclusions and recommendations based on its content   | The presentation ends abruptly without any summation for the audience   | The presentation has a brief conclusion but not substantial in content   | The presentation has a conclusion but some of the key points are not highlighted effectively  | Key points are clearly restated at the end of the presentation so that the audience clearly understands the purpose of the work                                 |
| <b>Q&amp;A</b><br>How well the presenters have addressed questions from the professor or the classmates  | Did not properly or correctly respond to any of the questions raised by the professor or by the classmates  | They answered satisfactory MOST of the questions raised by the professor or by the classmates  | They answered satisfactory ALL of the questions raised by the professor or by the classmates  | The answers to ALL of the questions raised by the professor or by the classmates were beyond expectations   |

# COLLEAGUE EVALUATION FORM – term project

The purpose of this evaluation is to determine the extent of each participant's efforts relative to the remainder of the group. Imagine that your team is paid \$10,000 for your efforts this semester. How would you divide that sum among the members of your team?

List below the members of your team including yourself and indicate their "payment" that would be appropriate for his/her effort. Return the form to Prof. Yassine before the last day of classes.

| NAME | SHARE |
|------|-------|
| 1.   |       |
| 2.   |       |
| 3.   |       |
| 4.   |       |

Print Your Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Comments:

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**The above information will be held in strictest confidence.**

**You will receive an incomplete grade on your project unless this form is turned in.**

## TENTATIVE LECTURE & HOMEWORK SCHEDULE

| Wk | Date           | Chapter / Topic  |
|----|----------------|--|
| 1  | Sept. 5, 2023  | <b>Overview of course and Introduction to Operations Research (OR)</b><br><b>Linear Programming (LP): Graphical Solution</b>   |
| 2  | Sept. 12, 2023 | <b>Linear Programming (LP): Models &amp; Formulation</b><br>HW #1 due  |
| 3  | Sept. 19, 2023 | <b>Simplex Method &amp; Revised Simplex Method (RSM)</b><br>Team formations<br>HW #2 due   |
| 4  | Sept. 26, 2023 | <b>Duality &amp; Sensitivity Analysis</b><br>Homework 1 and 2 Solution<br>HW #3 due  |
| 5  | Oct. 3, 2023   | No Class (I am attending a conference)   |
| 6  | Oct. 10, 2023  | <b>This Tuesday is scheduled as Monday BUT we will hold a makeup session if all students are ok</b><br><b>Network Models &amp; Methods</b><br>Transportation & Assignment Models<br>Minimum Spanning Tree (MST) & Shortest Route Problem (SRP) |
| 7  | Oct. 17, 2023  | <b>Review for Midterm</b><br>HW #4 due<br>Homework 3 and 4 Solution<br>Project proposal is due (1-pager)   |
| 8  | Oct. 24, 2023  | <b>Midterm Exam</b>  |
| 9  | Oct. 31, 2023  | <b>Network Models (Continued)</b>  |
| 10 | Nov. 7, 2023   | <b>Integer Programming</b><br>HW #5 due  |
| 11 | Nov. 14, 2023  | <b>Introduction to Probability</b><br>Project status/progress report is due (1-pager)  |
| 12 | Nov. 21, 2023  | <b>Decision &amp; Risk Analysis (DRA)</b>  |
| 13 | Nov. 28, 2023  | <b>Markov Chains (MC)</b><br>Homework 5 Solution<br>HW #6 due  |
| 14 | Dec. 5, 2023   | <b>Project Presentations</b><br>Homework 6 Solution<br><b>Review for Final Exam</b><br>HW #7 due   |
| 15 | Dec. 12, 2023  | <b>FINAL Exam</b>  |