EM 602-852 Management Science

Spring 2025

Students are expected to read and adhere to all terms outlined in the syllabus.

Contents

1 Course Overview

Management Science (MS) is a graduate-level that applies scientific methods to solve quantitative decision-making problems. Using Operations Research (OR) methodologies, MS addresses complex issues in fields such as services, manufacturing, and supply chain management.

Topics covered in this course include: 1) Linear Programming (LP) Formulation, 2) Graphical Solution Procedures, 3) Network Models, 4) LP Applications in Marketing, Finance, and Operations Management, 5) Simplex Method, 6) Sensitivity Analysis, 7) Duality, 8) Inventory Models, and 9) Queueing Models.

As a core course for an M.S. in Engineering Management (EM) at NJIT, this course provides essential knowledge cost and systems management.

The overall learning objectives include the development of mathematical models, the application of classical optimization techniques to solve problems, the analysis and evaluation of solutions generated by *Excel Solver*, and the interpretation of results to enhance decision-making processes. These learning outcomes align with the rigor and breadth of the EM program. Students are expected to meet high standards and requirements of the program, regardless of the instructional method.

1.1 Instructor

Dr. Cai is the instructor of this course. Please refer to Table 1 for her contact details. She is an Associate Professor in the Department of Mechanical and Industrial Engineering at the Newark College of Engineering. She joined NJIT in 2012 and has taught a number of courses, including IE 706 Queuing Theory and Applications, IE 650 Advance Topics in Operations Research, EM 602 Management Science, IE 459 Production Planning and Control, and IE 439 Deterministic Models in Operations Research.

Dr. Cai holds B.S. degrees in both Electrical and Computer Engineering and Operations Research & Industrial Engineering from Cornell University. She also earned an M.S. and a Ph.D. in Industrial Engineering & Operations Research from the University of California, Berkeley. Her research interest is in Operations Management, focusing on theoretical advancement in OR methodologies and techniques, as well as the applications of economic models in designing incentives to foster public-private partnership, managing sustainable energy systems, pricing in e-commerce, and primary care planning and scheduling.

Table 1: Instructor's Contact Information

Email address: cai@njit.edu	Phone: 973-596-3338	Office: MEC 308

1.2 Course Delivery via *Canvas*

This course will be conducted primarily asynchronously online using *Canvas*, NJIT's Learning Management System (LMS). Course materials, including recorded lectures, notes, homework assignments, exams, and grades, will be accessible on the course webpage at

https://njit.instructure.com/courses/38730.

Important information, including comments, corrections, and updates, will be posted on the course webpage. Students are responsible for checking it regularly. For those unfamiliar with Canvas, here are the Canvas Student Guides: link to Canvas Student Guides.

1.3 Course Prerequisite

Undergraduate-level knowledge of the following is required:

- Linear algebra: Matrix multiplications and Gaussian elimination (or row manipulation) are used in the Simplex method, sensitivity analysis, and duality.
- Calculus: Solving equations with derivatives is used in inventory models.
- Probability: Markov processes are used in queueing models.

1.4 Required Textbook

An Introduction to Management Science: Quantitative Approaches to Decision Making by Anderson et al. 15th Edition. Cengage, 2018. ISBN: 978-1-337-40652-9.

Both Chapter 17 and Chapter 18 are available under the Student Resources module on Canvas.

1.5 Course Restrictions

While the online version of this course offers greater flexibility compared to its in-person counterpart, it is important to understand its implications on exams. Here are online exam guidelines:

- Scheduling: All exams are scheduled for **2-5 pm Eastern Time on Sundays** (see Table 4 for dates).
- Proctoring: Exams must be proctored using the ***Respondus LockDown Browser and Monitor***.
- Equipment: ***A functioning microphone and camera*** accessible by the *Respondus LockDown Monitor* are required.
- Canvas Familiarity: Students must be familiar with with *Canvas* editors to answer various question types, including multiple-choice, true/false, fill-in-the-blanks, and essay questions. The latter necessitates students to articulate detailed responses, requiring proficiency in using *Canvas* editors.
- *Excel* Prohibition: *Excel* is prohibited during exams, even though it's used in solving complex problems in homework assignments.
- Calculators: Personal calculators are not allowed, but a scientific calculator is available through the *Respondus LockDown Browser*.

If these conditions are not suitable, consider taking the in-person version of the course.

1.6 Required Hardware and Software

Technical requirements To successfully participate in the course:

1. Computer: A personal computer that meets the following criteria: i) compatibility with the *Respondus LockDown Browser* and ii) equipped with a functioning microphone and webcam.
2. *Respondus LockDown Browser*: Download and install the browser from NJIT's Respondus Information Page.
3. *Excel* with Solver: You will be using *Excel* with its built-in *Solver*. See section 4.3 for a *Excel Solver* Q&A.

Exam Policy (Important):

1. Launch the *Respondus LockDown Browser* on your computers during exams;
2. You will be prompted to authorize the *Respondus Monitor* to access your webcam and microphone for the following purposes:
   (a) Recording pictured IDs issued by NJIT or government agencies.
   (b) Capturing your face during exams.
   (c) Scanning your environment at the start of each exam.

(d) Recording you throughout the exam duration.

Refusal to use the Respondus LockDown Browser, webcam, or microphone during exams will result in a zero score for that exam.

1.7 Academic Integrity

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: NJIT Academic Integrity Code.

Please note that it is the instructor's professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.

1.8 Generative Artificial Intelligence

Student use of artificial intelligence (AI) is permitted in this course for homework assignments. It is not permitted to be used in exams, as doing so would undermine the assessment of student learning and achievement of course learning outcomes. Additionally, if and when students use AI in this course, the AI must be cited as is shown within the NJIT Library AI citation page for AI. If you have any questions or concerns about AI technology use in this class, please reach out to the instructor prior to submitting any assignments.

1.9 Office Hours

The instructor holds open office hours via *Zoom* on Mondays, 8-9 pm Eastern time. No appointments are necessary. Simply click on the link provided on the *Canvas* course webpage to join the *Zoom* meeting. Drop in during office hours to ask questions about course materials, online discussions, or homework assignments.

1.10 Communications

Students are urged to contribute to the development of a collaborative learning community by posing questions on *Canvas Discussions* (see section 2.2 for details). In the event that a student emails the instructor with academic queries, the responses may be shared in *Canvas Discussions* to ensure that all students can benefit from the questions and their respective answers.

All emails and online posts should be professional in tone. See the following resources for guidance:

`https://www.wikihow.com/Email-a-Professor` and
`https://marktomforde.com/academic/undergraduates/Email-Etiquette.html`.

Expect responses within 48 hours during business hours, Monday-Friday, 8 am to 5 pm. Questions submitted on weekends will be addressed the following Monday.

2 Learning Activities and Assessments

This is a three-credit course requiring a minimum of 6 weekly hours for coursework and assignments. In the asynchronous online format, students bear an increased responsibility for taking ownership of their learning, potentially requiring additional time.

Although online learning can seem individualized, a strong instructor presence, guidance, and interaction are essential. The Department of Education mandates *Regular and Substantive Interaction* between students and instructors for federal financial aid eligibility. To support student learning and meet this requirement, the instructor incorporates various learning activities and assessments, including homework assignments, online discussions, and exams.

2.1 Homework Assignments

Homework assignments serve the dual purpose of aiding students in comprehending course topics and maintaining pace with the curriculum. Set deadlines ensure prompt provision of feedback, encompassing solutions and grades. The regular and frequent nature of homework assignments aligns with the Department of Education's mandate for *Regular and Substantive Interaction*, fostering a dynamic and engaging learning experience.

2.1.1 Homework Submission Policy

1. Submission Method:
    - All homework assignments are submitted through **Canvas Quizzes**.
    - Familiarize yourself with the various quiz features and question types to effectively complete assignments and prepare for exams.
    - Submissions via email will not be accepted under any circumstances.
2. Deadline:
    - All assignments are due by **11:30 PM on the due date**.
    - Late submissions will not be accepted and will receive zero points.
3. File Submission Requirements:
    - Depending on the assignment, you may be required to upload files containing your detailed work.
    - Adhere to the following file submission guidelines:
        - **PDF:**
            * For typed or scanned handwritten answers, create a single, well-organized PDF file.
            * Clearly label each part of the question (e.g., Part 1, Part 2, or Part a, Part b).
        - **Excel:**
            * Submit a single Excel file containing both the model and solution.
            * Use separate tabs or worksheets for different models.
            * **Note:** The instructor will run the model to verify the accuracy of your solution.
4. Separate File Submissions:
    - For assignments requiring multiple file submissions, submit a separate file for each individual problem.
    - This ensures efficient grading, prompt feedback, and allows for accurate assessment of your work.

Grading Example:
Consider an assignment with two questions (Q1 and Q2) that require file submissions.

- Correct submission:
    - Submit one file (F1) to Q1 and another (F2) to Q2.

  - Grading: Q1 will be graded based on F1, and Q2 will be graded based on F2.

- Incorrect submission:
  - Submit a single file (F) containing answers to both Q1 and Q2.
  - Submit no file for Q2.
  - Grading: Q1 will be graded based on the relevant portion of file (F). Q2 will receive zero points due to the lack of a submitted file.

2.1.2 Homework Grading

- **Full credit**: Follow instructions and meet criteria for each problem to ear full points.
- **Feedback**:
  - The primary focus of homework is learning.
  - Only token points will be deducted for incorrect answers.
  - The instructor will provide feedback to clarify concepts and guide you towards correct problem-solving approaches.
- **Effort**: Points will be deducted for work that demonstrates a lack of genuine effort. This includes incomplete assignments and work that do not follow instructions.
- **Grading Timeline**: The instructor aims to grade and post grades within two weeks of the submission deadline.

2.1.3 Homework Solutions

Homework solutions will be posted on *Canvas* after the submission deadline. Review your work against the solutions and ask questions during office hours or on *Canvas Discussions*.

2.1.4 Homework Collaboration

The instructor encourages students to form pairs and collaborate on homework assignments. However, it's essential to report such collaboration by answering the collaboration question in every homework assignment. Each student is responsible for submitting their own unique, individually prepared solutions. When applicable, each student must create their own Excel spreadsheet.

Academic Integrity Violations
The following actions constitute academic integrity violations:

- Copying the instructor's posted solutions.
- Submitting identical files by two or more students.
- Failing to accurately answer the collaboration question.
- Discrepancies in collaboration statements. This includes situations where one student claims to have worked alone while another claims collaboration with them, or there are conflicting reports of collaboration among multiple students.

Penalties for academic integrity violations are as follows:

- First offense: All students involved will receive a grade of zero on the assignment and a formal warning from the instructor.
- Second offense: All students involved will receive a grade of zero on the assignment and will be reported to the Dean of Students (DOS).
- Third offense: All students involved will fail the course.

2.2 Participation in Online Discussions

Students are encouraged to post your questions on *Canvas Discussions* instead of emailing. Online forum discussions are expected to be meaningful and of an academic nature to satisfy the *Regular and Substantive Interaction* requirement by the Department of Education. Discussions are divided into two types: mandatory participation and optional participation.

2.2.1 Mandatory Participation: Graded Discussions

The instructor will create a graded discussion for each topic. Every student must reply within the specified deadlines. Replies that do not meet the instructions will be considered **non-meaningful contributions** and may not receive full credits.

2.2.2 Optional Participation: Questions Asked by Students

When a student has a question, search existing discussions for answers. If no answer is found or the answer is unclear, feel free to reply to an existing discussion. Create a new topic only if the question has not been asked previously. All students are welcome to contribute to existing discussions.

2.2.3 Rules of Postings

1. Sharing answers to graded activities is **not** permitted.
2. Maintain a professional and respectful tone in your posts.

2.3 Exams

Two midterm exams and a final exam are scheduled, see Table 4 for exam dates. All exams are scheduled on Sunday afternoons, between 2pm and 5pm to accommodate students working full-time Monday-Saturday.

- **Delivery**: All exams are administered online.
- **Integrity**: To ensure academic integrity, students must use the *Respondus LockDown Browser* with webcam and microphone during exams.
- **Format**: Multiple versions of the exams will be used. They will be comprehensive (cumulative), closed book, and closed notes.
- **Allowed items**: Students may bring a pen, a pencil, and/or blank sheets of paper.
- **Prohibited items**: Electronics (calculators, cell phones, tablets, smart devices, computers other than the one used to take exams, etc.) are not permitted during exams. Students must confirm this in the environment check step in the *Respondus LockDown Browser*.
- **Cheating Consequences**: Students found cheating, as defined in the University Policy on Academic Integrity, will receive a course grade of XF and will be reported to the Dean of Students.

2.3.1 Exam Grading

- Essay questions: A grading rubric will be provided for essay questions requiring detailed work. Partial credits may be awarded.
- Other type of questions: Automatically graded.
- Timeline: The instructor aims to grade and post grades within 10 business days of the submission deadline.

2.3.2 Make-up Exam Policy

Make-up exams will NOT be granted unless there is an excusable absence approved by the Office of Dean of Students. Excused absences typical do **NOT** include (1) work matters, (2) personal or family commitments, (3) lack of preparation, (4) late exam starts, or (5) misinformation.

Make-up Exam Request Procedure:

1. Before the exam: Contact the Office of Dean of Students (DOS) at dos@njit.edu with documentation to support your reason for missing an exam. Do not copy the instructor on the email. See NJIT Academic Policies and Procedures* for student privacy information.
2. Emergencies: If you have an incapacitating illness or emergency that prevents contacting the DOS before the exam, notify them within 72 hours of the missed exam.
3. Approval Process: If the DOS approves a make-up exam, they will notify the instructor,w ho wil then contact you with the date and time. You cannot choose the date for the make-up exam.

2.3.3 Technical Issues during Exams

Students who cannot start or complete the exams because of technical issues (e.g., poor internet connections, *Respondus LockDown Browser* problems, computer updates) will **not** receive time extensions or make-up exams. Answers **cannot** be submitted after the exam, and the exam cannot be taken again.

To minimize technical issues, a practice exam will be provided. This allows students to ensure they have the proper software, equipment, and internet connections.

3 Course Grade

3.1 Numerical Grade

A weighted-average score is calculated based on homework assignments, online discussion participation, and exams. See Table 2 for the weight assigned to each category.

Table 2: Weights used in Average Score Calculation

Category	HW Assignments*	Participation in Online Discussion	Midterm Exam 1	Midterm Exam 2	Final Exam	Total
Weight	15%	5%	25%	25%	30%	100%

***Average Homework score** To accommodate students with external circumstances, the lowest three homework scores will be dropped. This means students can miss up to three homework submissions without affecting their overall average homework score.

An example of course score calculation: A student receives with the following scores receives a cumulative score of 84.0:

*The university continues to make every effort to protect students' academic and personal information. Moreover, maintaining the confidentiality of students' medical information is a legal and ethical duty, as defined by federal and state laws and regulations, and by the courts. Whenever students have a situation that affects their academic standing, it should be brought to the Dean of Students. This includes medical or psychological documentation to support a student's claim. Students should not bring such information to their instructors, nor should it be requested by a faculty member. The Dean of Students has a physician and staff psychologists to evaluate such information to verify its legitimacy. The Dean of Students will then notify the faculty member(s) if a student has a legitimate absence and will ask that the student receive consideration in making up any missed course work or exam. This process ensures confidentiality of students' information and, just as important, consistency in dealing with such matters.

- Average homework score (after dropping the lowest three): 95
- Participation in online discussion: 100
- Midterm exam 1: 85
- Midterm exam 2: 78
- Final exam: 80

Cumulative Score Calculation:

$$95 \times 15\% + 100 \times 5\% + 85 \times 25\% + 78 \times 25\% + 80 \times 30\% = 84.0$$

3.2 Letter Grade

The letter grade is determined by the weighted-average score, as shown in Table 3.

Table 3: Mapping Course Grade to Letter Grade

Course Score	≥ 84.0	≥ 76.0	≥ 68.0	≥ 60.0	≥ 52.0	< 52
Letter Grade	A	B+	B	C+	C	F

3.3 Extra Credit

No extra credits will be awarded. Please click here to read an article for a detailed explanation.

3.4 Incomplete (*I*)

The university's policy on requesting and awarding an I grade is as follows:

- The I grade is only given in rare instances when a student who would normally have completed the course work but who could not do so because of extenuating circumstances.
- When a student invokes extenuating circumstances and requests an I grade, the student must contact the Dean of Students first. The Dean of Students will be making the determination of whether extenuating circumstances exist or not and will be notifying the instructor accordingly.
- Except for cases determined by law, the instructor is **not** required to accommodate student requests even when extenuating circumstances are certified by the Dean of Students.
- When giving an I grade, the instructor will notify the student (and copy the Department Chair and the Dean of Students), in writing, of the exact work to be completed and the date by which it must be submitted.
- If the specified work is **not** submitted by the specified date. The I grade will be automatically changed to a F grade in the next regular semester.

An I grade when only be granted if **all** of the following conditions are met in addition:

1. The Dean of Students provides a written statement certifying the student's eligibility for an I grade.
2. The student has completed at least 70% of all coursework before requesting an I grade.
3. The instructor and student agree in writing, **before** the final grade due date, on the specific work to be completed and the submission deadline.

4 Other

4.1 Technical Assistance

For any technical difficulties with courseware like Canvas, WebEx, or Respondus LockDown Browser (including during exams), submit a ticket to the IST Service Desk:

https://ist.njit.edu/ist-service-desk.

The IST Service Desk will assign a representative to assist you. **Note: The instructor does not have administrative access or in-depth knowledge to troubleshoot technical issues.**

4.2 *Respondus LockDown Browser* Q&A

- *Q: What is the Respondus LockDown Browser?*

  A: It is a proctoring application that assists with the academic integrity of online exams by preventing students from printing, copying, going to another URL, or accessing other applications during an exam. Students cannot access the exam via a standard web browser.

- *Q: What role does the Respondus LockDown Browser play during an online exam?*

  A: It will access the students' webcams to record them during the entire exam.

- *Q: What role does the Respondus LockDown Browser play after an online exam?*

  A: It analyzes the recorded videos to catch violations of academic integrity. Click here to see NJIT's Academic Integrity Code.

- *Q: How does the Respondus LockDown Browser work?*

  A: Click here to watch a video and to get a basic understanding of the *Respondus LockDown Browser*.

- *Q: How to install the Respondus LockDown Browser?*

  A: Click here to install the *Respondus LockDown Browser*.

- *Q: How to do the Respondus Environment Check?*

  A: Click here for a YouTube video that shows how to do *Respondus Environment Check*. **Note**: the video demonstration allows for a calculator. However, students can not bring a calculator, as the latest version of the *Respondus LockDown Browser* includes a built-in calculator.

4.3 *Excel Solver* Q&A

- *Q: How will the Solver be used in this course?*

  A: The *Solver*, an *Excel* add-in, is used to solve complex linear programs.

- *Q: How to install the Solver?*

  A: Click here for directions.

4.4 Campus Resources

The most relevant on-campus resources are highlighted in this section.

- Robert W. Van Houten Library (http://library.njit.edu/) offers electronic and print resources, research assistance, and consultation services.
- Office of Accessibility Resources and Services (OARS), https://www.njit.edu/accessibility/ provides support and accomoodations for students with disabilities.
- Center for Counseling and Psychological Services (C-CAPS), https://www.njit.edu/counseling/,helps students achieve academic goals and personal success.

4.5 Modifications to Syllabus

The syllabus is subject to change. Students will be notified by the instructor of any modifications or deviations.

5 Tentative Schedule and Learning Outcomes

Table 4: Tentative Schedule and Learning Outcomes

Week	Topic	Textbook Chapters	Learning Outcomes
Tue, 1/21 - Sat, 1/25	Overview of MS	Ch1	Develop a general understanding of the MS (or OR) approach to decision-making.
Sun, 1/26 - Sat, 2/1	Intro to LP	Ch2	1. Formulate a LP problem with four components; 2. Solve a LP problem with two decision variables using the graphical solution procedure.
Sun, 2/2 - Sat, 2/8	Network Models	Ch6	1. Convert problems to transportation, transshipment, or assignment models; 2. Create LP models and solve them using *Excel*; 3. Interpret solutions and make recommendation to decisions.
Sun, 2/9 - Sat, 2/15	Applications of LP models	Ch4	1. Formulate problems in marketing, finance and operations management as LP problems; 2. Create LP models and solve them using *Excel*; 3. Interpret solutions and make recommendation to decisions.
Sun, 2/16 - Sat, 2/22	Exam1 Review	Ch2, 6, 4	Topics covered: 1. LP Formulation; 2. Graphical Solution Procedure; 3. Network Models; 4. Applications of LP models.
Sunday, 2/23	**Midterm Exam 1 via *Respondus LockDown Browser*, 2-5 pm**		
Sun, 3/2 - Sat, 3/8	Simplex Method	Ch17	1. Convert an LP to its Standard Form; 2. Perform Simplex iterations in tableau.
Sun, 3/9 - Sat, 3/15	Sensitivity Analysis	Ch3, 18.1	1. Revise the initial and the final Simplex tableau when either a right-hand-side (RHS) value or an objective function coefficient is changed to the original LP; 2. Compute the range of feasibility of a RHS value; 3. Compute the range of optimality of an objective function coefficient.
Sun, 3/16 - Sat, 3/22	**Spring break, no office hour**		

Table 4: Tentative Schedule and Learning Outcomes

Week	Topic	Textbook Chapters	Learning Outcomes
Sun, 3/23 - Sat, 3/29	Exam 2 Review	Ch2, 6, 4, 17, 3, 18.1	Topics covered: 1. LP Formulation; 2. Graphical Solution Procedure; 3. Network Models; 4. Applications of LP models; 5. The Simplex Method; 6. Sensitivity Analysis.
Sunday, 3/30	**Midterm Exam 2 via *Respondus LockDown Browser*, 2-5 pm**		
Sun, 4/6 - Sat, 4/12	Duality	Ch18.2	1. Find the Dual of any Primal problem; 2. Solve the Dual problem; 3. Use the solution of the Dual to identify the Primal solution.
Sun, 4/13 - Sat, 4/19	Inventory Models	Ch10	1. Set up an EOQ and an Economic Production Lot Size models to minimize the cost of an inventory system; 2. Determine how much to order and when to order.
Sun, 4/20 - Sat, 4/26	Queueing Models	Ch 11	1. Compute operating characteristics of a single-server or a multi-server queuing model; 2. Perform economic analysis of a system with waiting line(s).
Sun, 4/27 - Sat, 5/3	Final Exam Review	Ch2, 3, 4, 6, 10, 11, 17, 18	Topics covered: 1. LP Formulation; 2. Graphical Solution Procedure; 3. Network Models; 4. Applications of LP models; 5. The Simplex Method; 6. Sensitivity Analysis; 7. Duality; 8. Inventory Models; 9. Queueing Models.
Sunday, 5/11	**Final Exam via *Respondus LockDown Browser*, 2-6 pm**		
Sun, 5/18	**Course grade will be posted on Pipeline**		