New Jersey Institute of Technology

Digital Commons @ NJIT

Fall 2023

EM 602-853: Management Science

Wenbo Cai

EM 602-853 Management Science

Fall 2023

It is the responsibility of students to read and understand the course syllabus. Students enrolled in this course agree to all terms specified in the syllabus.

Contents

1 Course Overview

This is a graduate-level course on Management Science (MS), a discipline that facilitates managerial decision making by applying a scientific approach to problems with quantitative factors. MS adopts Operations Research (OR) methodologies and techniques to solve complex, real-world problems in various fields such as services, manufacturing, and supply chain.

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

As a core course a student must take to obtain an M.S. in Engineering Management (EM) at NJIT, this course is to provide knowledge in two functional areas that are the cornerstones of the discipline: cost management and systems management.

The overall learning outcomes include creating mathematical models, applying classical optimization techniques to solve problems, analyzing and evaluating solutions generated by *Excel Solver*, and interpreting solutions to facilitate decision making.

These learning outcomes are appropriate to the rigor and breadth of the EM program. Further, students are required to meet high standards and requirements of the program, regardless of the method of instruction.

1.1 Instructor

Dr. Cai is the instructor of this course. See Table 1 for her contact information. She is an Associate Professor in the Department of Mechanical and Industrial Engineering at the Newark College of Engineering. She joined NJIT as an Assistant Professor in Fall 2012 and has been teaching 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, IE 439 Deterministic Models in Operations Research.

She received a B.S. in both Electrical and Computer Engineering and Operations Research & Industrial Engineering at Cornell University and an M.S. and a Ph.D. from Industrial Engineering & Operations Research at University of California, Berkeley. Her research interest is in Operations Management, focusing on theoretical advancement of OR methodologies and techniques and economic models as well as their applications in managing sustainable energy systems, pricing in e-commerce, designing incentives to foster public-private partnership, 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 primarily conducted asynchronously online using *Canvas*, NJIT's Learning Management System (LMS). Recorded lectures, notes, homework assignments, exams, and grades are disseminated via the course webpage at

<div align="center">https://njit.instructure.com/courses/29609.</div>

The instructor will post important information, including comments, corrections, and updates on the course webpage. Students are responsible to check the course webpage regularly. Click this link to access the Canvas Student Guides.

1.3 Course Prerequisite

Undergraduate level of

- 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 are 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 can be found under the Student Resources module on Canvas.

1.5 Course Restrictions

While the online version of this course provides more flexibility than the in-person one, it is important to understand its implications on exams:

- All exams must be **taken online at 2-5 pm Eastern Time on Sundays** (see Table 4 for dates).
- All exams must be **proctored via the *Respondus LockDown Browser***.
- A microphone and a camera accessible by the *Respondus LockDown Monitor* are required.
- Students must learn how to use *Canvas* editors.
  - Exams contain different types of questions, such as multiple-choice, true/false, fill-in-the-blanks, and essay questions. The last type requires students to type up detailed work. Students must be willing to learn how to use *Canvas* editors.
- Students **cannot** use *Excel* during exams.
  - Even though *Excel* is an integral tool used in this course to solve complex problems, the *Respondus LockDown Browser* prevents its use during an exam.
- Students **cannot** use their own calculators. A scientific calculator will be enabled via the *Respondus LockDown Browser*.

If a student is uncomfortable with any of the exam settings, please take the in-person version of this course instead.

1.6 Required Hardware and Software

1. A personal computer that is i) compatible with the *Respondus LockDown Browser* and ii) equipped with a microphone and a webcam.

2. The *Respondus LockDown Browser*. This is an app that must be installed on students personal computers. See section 4.2 for a *Respondus LockDown Browser* Q&A.

   Important: Students must agree with the following to take exams:

   (a) Launch the *Respondus LockDown Browser* on their personal computers to take the exams;

   (b) Allow the *Respondus Monitor* to access webcams and microphones to (i) record pictured IDs issued either by NJIT or by a state/local government, (ii) take pictures of their faces, (iii) scan their environments at the start of each exam, and (iv) record them during the entire exams.

   A student who refuses to use the *Respondus LockDown Browser* along with a webcam and a microphone during the entire exam will receive a zero on the exam.

3. *Excel* with its built-in *Solver*. See section 4.3 for a *Excel Solver* Q&A.

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 students' degree. As members of the NJIT community, it is the responsibility of students to protect their educational investment by knowing and following the academic code of integrity policy, which can be found by clicking here.

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 lead to disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. Students who have questions about the code of Academic Integrity should contact the Dean of Students Office at dos@njit.edu.

1.8 Office Hours via *Zoom* on Thursdays, 7:30-8:30 pm

The instructor conducts office hours via Zoom on Thursdays, 7:30-8:30 pm. No need to make appointments. To access the *Zoom* meeting, click on the page posted on Canvas. During office hours, the instructor will answer questions regarding the course materials, online discussions, and homework assignments students may have.

1.9 Communications

Students are encouraged to help foster a learning community by posting questions on *Canvas Discussions* (see section 2.2 for details). If a student emails the instructor questions of an academic nature, the instructor will answer these questions in *Canvas Discussions* instead so all students can benefit from the questions and answers.

The instructor will **not** answer emails or online posts that are not **professional**. The following links offer examples of professional email etiquette, but it also applies to online posts:

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

A response will be provided within 48 hours during normal business hours: Monday - Friday between 8 am and 5 pm. Questions received or posted on Saturdays and Sundays will be replied on Monday.

2 Learning Activities and Assessments

This is a three-credit, semester-long course. Students should expect to spend at least 6 hours per week on coursework and assignments. In an asynchronous online format, students have a heightened responsibility to take ownership of their learning and it may require more time.

Online learning, however, should not be a solitary experience. It can only be successful with a strong instructor presence, guidance, and initiation. In fact, the Department of Education requires *Regular and Substantive Interaction* between students and the instructor to ensure federal financial aid funds were used appropriately.

Additionally, group learning is an effective learning strategy, even in an online learning environment. To facilitate student learning and to satisfy the *Regular and Substantive Interaction* requirement of the Department of Education, the instructor includes the following types of learning activities and assessments: homework assignments, online discussions, and exams.

2.1 Homework Assignments

Homework assignments are intended to help students learn the topics and keep up with the pace of the course. Deadlines are set so feedbacks, such as solutions and grades, can be offered promptly. Homework assignments are regular and frequent to satisfy the *Regular and Substantive Interaction* requirement of the Department of Education.

2.1.1 Homework Submission Policy

- **Canvas Quizzes** are used for homework submissions. Learning the features and functionalities (such as the different types of questions and the editors) of *Canvas Quizzes* help students prepare for exams.

- The cutoff submission time is set at **11:30 pm on the due date.**

- **Late submission is not accepted and will receive zero points.**

- **No submissions via email will be accepted.**

- Depend on the questions, students may be asked to type their answers in the given space or to upload files that contain detailed work. Only two formats are accepted: portable document format (pdf) and *Excel* spreadsheet (xls or xlsx).

  – If a question requires a pdf file submission, students may either type up their answers or scan their hand-written answers. Label each part of the question and sort them either in a numerical order (part 1, part 2, etc.) or in an alphabetical order (part a, part b, etc.).

– If a question requires an xls or xlsx submission, students must submit a single *Excel* spreadsheet that includes both the model and the solution. The instructor will run the model to check whether the solution is generated by the *Solver*. Use multiple tabs if more than one model is required.

- **Submit a separate file for each problem that requires a file submission**. This is the most efficient method because it

  – ensures consistency in grading: the instructor can grade the answers to one question from all students before moving on to the next question.
  – facilitates prompt feedback: the instructor needs to minimize time in opening up files, loading pages, and searching for answers. Otherwise, feedback will be delayed significantly and students learning may be negatively affected.
  – allows for outcome assessment: the instructor can link a problem to a learning outcome and analyze whether or not mastery of the learning outcome is achieved. This is an important step in continuous improvement required by accreditation.

  Example of how homework questions are graded: Two questions (Q1 and Q2) in an assignment 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 assigned a grade. Q2 will be graded, after everyone's Q1 is graded, based on F2 and assigned another grade.
  – Incorrect submission: Submit a single file (F) to Q1 and submit no file to Q2. F has answers to both Q1 and Q2. Grading: Q1 will be graded based on F and assigned a grade. Q2 will receive zero points because no files were submitted to Q2.

2.1.2 Homework Grading

- To receive full points, students must follow the instructions and meet the criteria specified for each problem in a homework assignment.

- The instructor will not deduct points for incorrect work. Instead, the instructor will provide meaningful feedbacks when the approach is incorrect or to clarify a concept.

- The instructor will deduct points for work that lack genuine effort.

- The instructor will finish grading and post grades within 2 weeks of the submission deadline.

2.1.3 Homework Solutions

Homework solutions will be posted on *Canvas* shortly after the submission deadline. **Students are responsible to compare their work to the homework solutions** and ask questions during office hours or via *Canvas Discussions*.

2.1.4 Homework Collaboration

The instructor strongly encourages students to form pairs and collaborate on homework. **Students, however, must report such collaboration by answering the first question in every homework assignment. Further, every student must type-up or write-up the solutions himself/herself and create his/her own *Excel* spreadsheet when applicable.**

The following acts violate academic integrity:

- Two or more students submit the same file;

- The collaboration question is not answered;

- Statements of collaboration do not corroborate. Example: A stated working alone, while B claimed to work with A.

Penalty for violating academic integrity:

- First offense: all students receive a zero on their homework, along with a warning from the instructor.

- Second offense: all students are reported to the DOS in addition to receiving a zero on their homework.

- Third offense: all students fail the course.

2.2 Participation in Online Discussions

Canvas Discussions will be used for online discussion. The instructor encourages students to post your questions on *Canvas Discussions* rather than 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. These 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 will be required to reply in the same thread within one to two weeks. Be sure to follow the instructions given in the initial post. Replies that do not meet the instructions are classified as **non-meaningful contributions**. They will not receive full credits.

2.2.2 Optional participation: questions asked by students

When a student has a question, first search to see whether or not a discussion has been previously created and an answer has been provided. Feel free to reply to a discussion if there is no answer or the answer is not clear. Create a new topic only if the question has not been asked. All students are welcome to contribute to existing discussions.

2.2.3 Rules of Postings

1. Sharing answers to graded activities, such as assignments, are **not** permitted.

2. Postings that are unprofessional, disrespectful, or offensive will be deleted.

2.3 Exams

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

- All exams are administered online.

- To ensure academic integrity, all students are required to use the *Respondus LockDown Browser* with microphones and webcams during the exams.

- Multiple versions of the exams will be used.

- The exams are comprehensive (or cumulative), closed book, and closed notes.

- Students may bring blank sheets of paper.

- No electronics (calculators, cell phones, tablets, computers, smart devices, etc.) other than the computer used to take the exam are permitted.

- Students must show that none of unauthorized items are included during the environment check step in the *Respondus LockDown Browser*.

- Students found cheating on the exams, as defined in the NJIT's Academic Integrity Code, will receive a grade of F for the course and be reported to the Dean of Students.

2.3.1 Exam Grading

- A grading rubric will be provided for each essay question that asks students to show detailed work. Partial credits may be awarded.

- The instructor will finish grading and post grades within 10 business days of the submission deadline.

2.3.2 Make-up Exam Policy

Make-up exams will NOT be administered unless it is an excusable absence approved by the Office of Dean of Students. Typical reasons that will **not** grant a make-up exam include, but not limited to, (1) work matters, (2) other personal or family commitments, (3) lack of preparation, (4) start the exam late for any reason, or (5) misinformation.

Procedure to Request a Make-up Exam: To properly report absence of an exam, students must do the following:

1. Contact the Office of Dean of Students (DOS) at dos@njit.edu **before** the exam. Provide necessary documentation to support the student's reason for missing an exam. To protect students' privacy*, do **not** copy the instructor on the email.

   Note: Students who have incapacitating illness or emergencies that prevent them from contacting the Office of DOS before or during the exam must notify the Office of DOS within 72 hours of the missed exam.

2. If circumstances warrant a makeup exam, the Office of DOS will email a formal notice to the instructor. The instructor will then notify the student the date and time of the makeup exam. Students cannot pick the date.

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*NJIT Academic Policies and Procedures states the following: 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.

2.3.3   Technical Issues during Exams

Students who cannot start or complete the exams because of technical issues (such as poor internet connections, failure to install or to launch the *Respondus LockDown Browser*, automatic updates of personal computers, etc.) will **not** receive time extensions or make-up exams. Students **cannot** submit answers after the exams or take the exam again.

To minimize technical failure during exams, a practice exam will be given to students. It provides students an opportunity to make sure that they have the proper software, equipment, and internet connections.

3   Course Grade

A weighted-average score is calculated based on a student's performance in homework assignments, online discussion, midterm and final 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 HW score__ calculation: For various reasons (health, work, religion, etc.), students may not be able to submit their homework. The lowest three scores from homework assignments will be dropped. Therefore, a student who misses up to three (3) homework submissions will have no negative impact on their average HW score.

Example of course score calculation: A student receives an average score of 95 on homework assignments (after dropping the lowest three), 100 on participation in online discussion, 85 on exam 1, 78 on exam 2, and 80 on the final, the student's cumulative score is

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

3.1   Letter grade

Mapping from a weighted-average score to a letter grade follows Table 3.

Table 3: Letter Grade based on Course Grade

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

3.2   Extra Credit

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

3.3 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.

The instructor will only grant an I grade when **all** of the following conditions are satisfied:

1. There is a written statement from the Dean of Students certifying the student's circumstance qualifies for an I.

2. The student has completed at least 70% of all coursework when requesting an I grade.

3. The instructor and the student are able to come to an agreement in writing, **before** the final grade due date, on the exact work to be completed and the date by which it must be submitted.

4 Other

4.1 Technical Assistance

The Office of Digital Learning manages all courseware, such as *Canvas*, *Zoom*, and *Respondus LockDown Browser*. When encountering any technical issue with any courseware (even during an exam), submit a ticket to the IST Service Desk using this website:

<div align="center">

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

</div>

The IST Service Desk, after receiving a ticket, will assign a representative to help resolve the technical issue. **Please note that the instructor has neither the admin authorization nor the in-depth knowledge to help students with 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*. <u>Note</u>: the video demonstration allows for a calculator. However, students may not bring a calculator because the newest version of the *Respondus LockDown Browser* already provide one.

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.

- The Robert W. Van Houten Library (http://library.njit.edu/) offers electronic and print resources, including a core collection of academic books, databases, and journals, as well as research and consultation services.

- The Office of Accessibility Resources and Services (OARS), https://www.njit.edu/accessibility/, works in partnership with administrators, faculty and staff to provide reasonable accommodations and support services for students with disabilities.

- The Center for Counseling and Psychological Services (C-CAPS), https://www.njit.edu/counseling/, is committed to assisting students in the achievement of their academic goals as well as benefiting from their personal experience on campus.

4.5 Modifications to Syllabus

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

5 Tentative Schedule and Learning Outcomes

Table 4: Tentative Schedule and Learning Outcomes

Week	Topic	Textbook Chapters	Learning Outcomes	Assignment : Due Date
9/5- 9/8	Overview of MS	Ch1	Develop a general understanding of the MS (or OR) approach to decision-making.	Mandatory Discussion: 9/11
9/11- 9/15	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.	HW1: 9/18
9/18- 9/22	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.	HW2: 9/25
9/25- 9/29	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.	HW3: 10/2
10/2- 10/6	Midterm 1 Review	Ch2, 6, 4	Topics covered: 1. LP Formulation; 2. Graphical Solution Procedure; 3. Network Models; 4. Applications of LP models.	Practice Exam: 10/9
10/15	**Midterm 1 Exam via *Respondus LockDown Browser*, 2-5 pm**			

Table 4: Tentative Schedule and Learning Outcomes

Week	Topic	Textbook Chapters	Learning Outcomes	Assignment : Due Date
10/16- 10/20	Simplex Method	Ch17	1. Convert an LP to its Standard Form; 2. Perform Simplex iterations in tableau.	HW4: 10/23
10/23- 10/27	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.	HW5: 10/30
10/30- 11/3	Midterm 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.	
11/12	**Midterm 2 Exam via *Respondus LockDown Browser*, 2-5 pm**			
11/13- 11/17	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.	HW6: 11/20
11/20- 11/24	Thanksgiving Recess - No new topics. No office hours			Mandatory Group Learning: 11/27

Table 4: Tentative Schedule and Learning Outcomes

Week	Topic	Textbook Chapters	Learning Outcomes	Assignment : Due Date
11/27- 12/1	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.	HW7: 12/4
12/4- 12/8	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).	HW8: 12/11
12/11- 12/15	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.	
12/17	**Final Exam via *Respondus LockDown Browser*, 2-6 pm**			
12/25	**Course Grade Posted on Pipeline**			