BOB JONES UNIVERSITY
College of Arts & Science

Division of Mathematical Sciences

Ma 371❖ Linear Optimization

Fall 2024

Instructor: Dr. Laurel Carpenter
Office: AL 46
Office Hours: schedule via https://calendly.com/llcarpen
Email: llcarpen@bju.edu
Preferred Contact: MS Teams or email
Lecture: TTh 1:30-2:45, AL 315

Textbook: Hillier & Lieberman, *Introduction to Operations Research,* 11th edition
Technology Recommendations: TI-89 or TI-Nspire (or similar); laptop with MS Excel

Catalog Description: A study of linear programming methods employed in operations research. Topics include an introduction to modeling, the theory and application of the simplex method, duality and sensitivity analysis with applications directed toward business.

Course Context: Linear Optimization is a recommended course for the following programs: Mathematics, Actuarial Sciences, and Engineering.

This course supports the following Core Goals (IG) of this institution, goals (MS) of the Division of Mathematical Sciences, and program learning outcomes (MM) for the mathematics major in which, upon degree completion, the student will…

IG 2: Communicate effectively by various means in a variety of contexts.
IG 3: Understand the human experience within the framework of … natural sciences, and mathematics.
IG 4: Analyze, evaluate, and synthesize information and ideas.
IG 5: Solve problems through critical and creative thinking, working independently or collaboratively.
MS 1: Understand the essential theory of mathematics… and appropriately apply the theory in solving problems.
MS 2: Use critical-thinking/analytical skills to understand mathematical… problems and design solutions with the aid of appropriate tools.
MS 3: Apply an understanding of how mathematics… can be used as a tool to examine the natural universe.
MS 4: Construct a foundation upon which they, after graduation, can continue the development of their abilities and the learning necessary for work and life.
MM 1: Progress logically from premises to valid conclusions in a variety of mathematical contexts.
MM 2: Apply mathematics to model real-life situations.
MM 3: Select and use technology for understanding, as well as a labor-saving or problem-solving tool.
MM 4: Construct a biblically consistent philosophy of mathematics.

Course Learning Outcomes: Upon completion of this course, the student should be able to do the following with at least 70% accuracy:

1. Articulate the basic concepts of operations research (OR) and, in particular, linear programming.
2. Formulate and solve a basic linear programming model.
3. Use appropriate computer software to successfully solve for an optimal solution of a linear programming model.
4. Describe the steps of the simplex method and its underlying theory.
5. Use the simplex method to successfully solve for an optimal solution of a linear programming model.
6. Summarize and discuss the essential ideas behind sensitivity analysis.
7. Describe duality theory and how to formulate a dual problem.
8. Formulate and solve a dual problem.
9. Perform sensitivity analysis on a solution of a linear programming model.
10. Summarize and discuss other algorithms for linear programming such as the Dual Simplex Method, parametric linear programming, the Upper Bound Technique, and an interior-point algorithm.
11. Summarize and discuss historic and contemporary uses of operations research.

Grading and Assessment

Grading Scale:

Final grades will be assigned according to a standard 10 percentage-point scale calculated out of the total points on assessments during the semester. Percentages will be rounded to the nearest whole percentage when determining final grades.

Grades are determined by the total points made up of the following categories:

Case Studies:

Case studies are in-depth applications that draw connections between the text material and real-world applications.

- One case study is assigned per unit out of the possible case studies listed at the ends of chapters for that unit. Case study to be determined by student interest and instructor consent.
- Case studies are worth approximately 30 points each.
- The case study write-up will be written in essay form and will address all questions posed in the text. Any supporting work should be attached at the end of the essay.
- Case Studies are to be submitted via Teams by the due date in the schedule.

Article Summaries:

Summaries of journal articles about OR used in current, real-world applications are to be completed for most chapters.

- Article summaries are worth approximately 15 points each.
- Recommended articles per chapter are listed in Teams.
- Each student in class will summarize an article of their choosing.
  - Summaries will typically be 150 to 300 words and should include an overview of the problem or development being addressed, where/how it is applied, and a brief synopsis of the solution or procedure. The paper should also include a full citation for the article.
- Students should be ready to discuss the article they read in class.
- Article Summaries are to be submitted via Teams by the due date in the schedule.

Project and Presentation:

A course Project and Presentation will begin during Unit 3. The project is designed as a capstone for this course and requires the student to prepare, write a paper on, and present a topic from linear programming that was not discussed in lecture.

- The project and presentation are together worth approximately 60 points.
- Possible sources for this topic may include real-world applications from current published peer-reviewed journals or sections from Chapters 6-8 not lectured.
- Students will work in teams of two for preparation and presentation but will write individual reports.
- Students may choose their topic subject to instructor approval.
- The project report will address theory and application and will make connections between the topic and LP theory as taught throughout the course. Further instructions are posted in Teams.
- Each team of students is expected to present their topic before the class. Presentations are expected to be 30-35 minutes. Students should be prepared to answer questions related to their presentation.
- Presenting teams must also assign one or two problems over their topic. Problems may be from the textbook but must encapsulate the essence of the topic. The team must submit worked-out solutions of these problems to the instructor on the day of the presentation.
- The paper will be 70% of the Project and Presentation grade; the presentation will be 20% of the grade; and the problem assignment and solution(s) will be worth 10% of the grade.
- Students missing their presentation will forfeit 50% of their Project and Presentation grade. Students missing other students' presentations will forfeit 20% of the grade on their own project.
- Presentations may be delayed only for extenuating circumstances with the instructor's approval and only if time in the course allows.

Tests and Cumulative Exam:

- There will be three unit tests and a cumulative exam.
- Each test and exam are worth approximately 60 points.
- All tests will be closed-book and will allow the use of a stand-alone calculator.
- Missed tests due to extenuating circumstances may be made up only with the instructor's permission and will incur a 10% per day penalty for three days, after which the grade will be 0.

Final Semester Reflection and Chapter 8 Assignments:

- The final semester reflection will be a 300-word reflection on what students learned over the course of the semester and how it fits into their overall mathematical path and worldview.
- There will be various exercises assigned from the textbook on Chapter 8 topics presented by other students. All students are expected to complete these exercises.
- This grade will account for approximately 30 points.

Other Policies

Classroom Deportment

The classroom is a professional environment. Students are expected to be respectful to their instructor and peers in behavior, attitude, attire, and use of technology. The instructor has the right to require students who are participating in distracting behavior to leave the class.

Absences:

Students who miss more than 3 lectures may be dropped from the course. Missing more than 20 minutes of any part of a lecture or lab may count as a full absence. Students should notify the instructor by email as soon as possible after an absence (preferably within 24 hours). If the absence is planned, the student should notify the instructor before missing class. Students who are absent are personally responsible to obtain notes from fellow classmates.
BJU attendance policy is in effect (see https://home.bju.edu/bju-policies/ for details).

Academic Honesty and Integrity Policy:

BJU academic honesty and integrity policy is in effect (see https://home.bju.edu/bju-policies/ for details).

University Policies: We will follow University guidelines.

Copyright Policy:

Ma 371 Fall 2024 **Tentative Schedule**		
Date	Class	Assignment
Unit 1: Introduction to Linear Optimization (Chapters 1-3)		
Th, Aug 28	Intro to Lin Op, **Ch 1 & 2**	
T, Sep 3	**Ch 3**	
Th, Sep 5		
T, Sep 10	Examples (Student-Led Discussions)	• Ch 3 Article Summary
Th, Sep 12	**Unit 1 Test**	• Unit 1 Case Study
Unit 2: The Simplex Method (Chapters 4-5)		
T, Sep 17	**Ch 4**	
Th, Sep 19		
T, Sep 24		• Ch 4 Article Summary
Th, Sep 26	**Ch 5**	
T, Oct 1		
Th, Oct 3		• Ch 5 Article Summary (Primary Source)
T, Oct 8	Examples (Student-Led Discussions)	
Th, Oct 10	**Unit 2 Test**	• Unit 2 Case Study
Unit 3: Duality and Sensitivity (Chapters 6-7)		
T, Oct 15	**Ch 6**	
Th, Oct 17		
T, Oct 22	***Fall Break***	
Th, Oct 24		
T, Oct 29	Examples (Student-Led Discussions)	• Ch 6 Article Summary
Th, Oct 31	**Ch 7**	
T, Nov 5		
Th, Nov 7		
T, Nov 12	Examples (Student-Led Discussions)	• Ch 7 Article Summary
Th, Nov 14	**Unit 3 Test**	• Unit 3 Case Study
Unit 4: Further Topics (Chapter 8)		
T, Nov 19	Project workday	
Th, Nov 21	Project workday	
Nov 25-29	***Thanksgiving Break***	
T, Dec 3	**Cumulative Exam (Chapters 3-7)**	
Th, Dec 5	Presentations	• All Project/Presentation Deliverables
T, Dec 10	Presentations	
Th, Dec 12	Presentations	
W, Dec 18 12:30-1:40	**Semester Final Reflections**	• Ch 8 Assignments