Ma 390❖ Linear Optimization

Fall 2022

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 12:00-1:15, AL 202

Textbook: Hillier & Lieberman, *Introduction to Operations Research,* 10th edition,
Technology Requirements: 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 available during the semester. Percentages will be rounded to the nearest whole percentage when determining final grades.

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

Study Portfolio:

- Study portfolios will be due (in credenza) by noon on Monday following the completion of a chapter or on the day of the unit test (in class) if the chapter is the last in the unit.
- Study portfolios are worth approximately 7 points per chapter.
- Study portfolios are to be organized by chapter and must contain:
  - Concept maps for the chapter; definitions, theory, algorithms along with your thoughts and an accompanying example
  - Worked out exercises for the chapter
  - Case studies (one per unit) – typed
  - Copies of your article summaries – typed
  - Study Log; date, time spent, activity (report total time at the top)
- Work must be neat and well organized.
- Homework **should be worked out in detail**. Answers alone are not acceptable.
- Most exercises should begin on a new page and must include the exercise number (#.#-# format) and given information. Graphical and/or Excel printouts and handwritten work should be collated.
- Delayed portfolios will receive a 10% per day penalty.

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 20 points each.
- The case study write-up will be written in essay form and will address all questions posed in the text. Further instructions are posted in Canvas.

Article Summaries:

Summaries of journal articles about OR used in current, real-world applications are to be published as discussion board posts in Canvas for selected most chapters.

- Article summaries are worth approximately 10 points each.
- Recommended articles per chapter are listed in Canvas.
- Each student in class will summarize an article of their choosing. Further instructions are posted in Canvas.
- Students should read and respond to at least two other posts.
- Article Summaries and responses due dates are designated 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 application from current published peer-reviewed journals, case-studies from the text, 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 Canvas.
- Each team of students is expected to present their topic before the class. Presentations are expected to be 15±2 minutes. Further instructions are posted in Canvas.
- The paper will be 80% of the Project and Presentation grade; the presentation will be 20% of the grade. However, students missing their presentation will forfeit 50% of their Project and Presentation grade.
- Students should be prepared to answer questions related to their presentation.
- Presentations may be delayed for extenuating circumstances only with instructor's approval and only if time in the course allows. Delayed presentations will incur a 20% penalty.

Tests and Final exam:

- There will be three unit tests and a final 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 instructor's permission and will incur a 10% per day penalty. The final may not be made up.

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 390 Fall 2022 Tentative Schedule		
Date	Class	Assignment
Unit 1: Introduction to Linear Optimization (Chapters 1-3)		
Th, Aug 25	Intro to Lin Op, **Ch 1 & 2**	
T, Aug 30	**Ch 3**	
Th, Sep 1		• Ch 2 Article Discussion Board (Canvas)
T, Sep 6		
Th, Sep 8		• Ch 3 Article Discussion Board (Canvas)
T, Sep 13	**Unit 1 Test**	• Unit 1 Case Study (Canvas) • Ch 1 & 2 Portfolio (in class) • Ch 3 Portfolio (in class)
Unit 2: The Simplex Method (Chapters 4-5)		
Th, Sep 15	**Ch 4**	
T, Sep 20		
Th, Sep 22		
T, Sep 27		
Th, Sep 29	**Ch 5**	• Ch 4 Article Discussion Board (Canvas) • Ch 4 Portfolio (in credenza – Monday noon)
T, Oct 4		
Th, Oct 6		• Ch 5 Article Discussion Board (Canvas)
T, Oct 11		
Th, Oct 13	**Unit 2 Test**	• Unit 2 Case Study (Canvas) Ch 5 Portfolio (in class)
Unit 3: Duality and Sensitivity (Chapters 6-7)		
T, Oct 18	***Fall Break***	
Th, Oct 20	**Ch 6**	
T, Oct 25		
Th, Oct 27		
T, Nov 1		
Th, Nov 3	**Ch 7**	• Ch 6 Article Discussion Board (Canvas) • Ch 6 Portfolio (in credenza – Monday noon)
T, Nov 8		
Th, Nov 10		• Ch 7 Article Discussion Board (Canvas)
T, Nov 15		
Th, Nov 17	**Unit 3 Test**	• Unit 3 Case Study (Canvas) • Ch 7 Portfolio (in class)
Nov 21-25	***Thanksgiving Break***	
Unit 4: Further Topics (Chapter 8)		
T, Nov 29	Project workday	
Th, Dec 1	Project workday	
T, Dec 6	**Cumulative Exam**	
Th, Dec 8	**Project Presentations**	
M, Dec 12	**Project Presentations**	