Ma390
Linear Optimization
2020-21 First Semester

Instructor:	Dr. Laurel Carpenter
Office:	AL 46
Office Hours:	MWThF 1:30-2:30 virtual by appointment T by appointment
Email:	llcarpen@bju.edu
Telephone:	864-370-1800 x8194

Course 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. *Pre-req: Ma300*

Course Context:

The faculty of the Division of Mathematical Sciences has developed five broad goals and has aligned these goals with the Bob Jones University Institutional Goals (IG) and the goals of the Bible and Liberal Arts Core (BLA). We believe these goals support the IG/BLA of the University.

This course also supports one or more of the following goals of the Division of Mathematical Sciences (DG):

1. Mature the student in the theory and applications of mathematics and computer science.
2. Provide the student the required mathematical and computing background to function and contribute effectively in today's technological society.
3. Provide the student a platform for continued learning and development of his God-given abilities.
4. Instill in the student a desire to use his abilities in service to Christ.
5. Provide an appropriate liberal arts complement to a wide variety of majors.

This course also supports one or more of the following goals for a Mathematics Major (MM):

1. Graduates will exhibit maturity in the development and implementation of mathematical procedures.
2. Exhibit independent and abstract thought and make judgments about the value of innovative developments from a Biblical world view.
3. Display understanding of what constitutes mathematics, including its role within the framework of Biblical Truth.
4. Provide a solid foundation for graduate studies in mathematics.

Course Goals (CG):

In this course, I will attempt to:

1. Develop a good attitude in each student toward mathematics in general and mathematical reasoning in particular. (DG 1, 3, 4 and MM 2, 3)
2. Develop qualities in each student such as perseverance, diligence, and dependence on God. (DG 1, 3 and MM 4)
3. Teach the students an understanding of basic Linear Programming problem formulation. (DG 1, 2 and MM 1, 4)
4. Help the students to develop a basic understanding of common Linear Programming computer solvers such as EXCEL Solver and LINGO. (DG 1, 2, 3 and MM 1, 2, 4)
5. Expose students to Mathematical Journal articles in Operations Research and to require them to write a summary paper of one article per chapter, thus developing their technical writing skills. (DG 3 and MM 2, 3, 4)
6. Develop the ability of the students to work independently by requiring them to complete a Self-Study project that requires them to teach themselves the concepts of three sections in the textbook as well as doing problems based on these sections. (DG 1, 2, 3 and MM 1, 2, 3, 4)

Learning Objectives:

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. (CG 1, 2) (Assessment: Unit 1 and Cumulative Exam)
2. Formulate and solve a basic linear programming model. (CG 1, 2, 3) (Assessment: Unit 1 Test, Unit 2 Test, and Cumulative Exam)
3. Use appropriate computer software to successfully solve for an optimal solution of a linear programming model. (CG 1, 2, 3, 4) (Assessment: Unit 1 Test, Unit 2 Test)
4. Describe the steps of the simplex method and its underlying theory. (CG 1, 2, 3) (Assessment: Unit 2 Test and Cumulative Exam)
5. Use the simplex method to successfully solve for an optimal solution of a linear programming model. (CG 1, 2, 3, 4) (Asssessment: Unit 2 Test and Cumulative Exam)
6. Summarize and discuss the essential ideas behind sensitivity analysis. (CG 1, 2, 3) (Assessment: discussion post and/or class discussion)
7. Describe duality theory and how to formulate a dual problem. (CG 1, 2, 3, 4) (Assessment: Unit 3 and Cumulative Exam)
8. Formulate and solve a dual problem. (CG 1, 2, 3, 4) (Assessment: Unit 3 Test and Cumulative Exam)
9. Perform sensitivity analysis on a solution of a linear programming model. (CG 1, 2, 3, 4) (Assessment: Unit 4 Test and Cumulative Exam)
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. (CG 1, 2, 6) (Assessment: discussion post and/or class discussion)
11. Summarize and discuss historic and contemporary uses of operations research. (Assessment: discussion post and/or class discussion)

COURSE ASSESSMENT AND GRADING

Activities and Assessment

The course grade will be based on performance in the following activities.

Category	% of Grade	Description
Homework	13.3 % 100 pts	• Homework Checks: One homework check per unit. (3, 25 points each) • Portfolio Checks: Periodic checks of homework completion (5, 5 points each)
Unit Tests	40 % 300 pts	• Unit Tests: ○ In-class, closed-book, 50-minute tests focusing on theory and by-hand application from the unit (3, 75 points each) ○ Take-home, open-book, untimed tests focusing on in-depth analysis and/or technology assisted solutions from the unit (3, 25 points each)
Cumulative Exam	13.3 % 100 pts	• Cumulative Exam: In-class, closed-book, cumulative, 70-minute exam focusing on application (1, 100 points)
Article Summaries	10 % 75 pts	• Discussion Boards: Read-post-respond discussions on real-world uses of OR (5, 15 points each)
Case Studies	10 % 75 pts	• Case Studies: Written reports following case studies chosen from the textbook. One case study per unit. (3, 25 points each)
Project	13.3 % 100 pts	• Semester project and presentation independently developing a topic from Chapters 6-8 not covered in lecture (1, 100 points total)

Homework

Because homework is one of the primary means by which students develop good mathematical insight, it is crucial to success in this course. Homework in linear programming includes more than just working *exercises*. Homework also includes reading and understanding textbook examples and being able to make connections and apply LP in many different scenarios. For this reason, personal study habits will be considered as important as working exercises.

- Readings and Exercises are correlated to the lectures and are listed on Canvas. Exercises sets are a combination of theory, by-hand, and technology-assisted problems.
- ***Homework portfolio:*** Examples of your homework will be asked for periodically throughout the semester as designated in the course schedule.
  - Keep a portfolio ready to hand in. The portfolio will be graded on neatness, clarity, correctness, and completion. The portfolio is to be cumulative, so add to it as you complete the assigned exercises.
- ***Homework check*** is due before each Unit Test and is graded by a self-evaluation on performance and study habits via Canvas.

Tests

- Unit tests are written tests and occur in lecture class on the days designated in the schedule. In-class tests will cover a combination of theory and by-hand application.
- Each unit test will focus on information from that unit but may also contain questions from previous units especially as connections are made with previous material.

Cumulative Exam

- The Cumulative Exam is a written test and occurs during the final regular class session before final exam days.
- The Cumulative Exam covers theory and application from the entire semester especially and focuses on the connections between the different LP methods discussed. The exam may include information from any of the lectures, labs, readings, and homework throughout the semester.

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 each of Chapters 2, 3, 4, 6, and 7.

- Recommended articles per chapter are listed in Canvas.
- Each student in class will summarize in 0.5 to 1.5 pages (11-12 pt font, 1.5 spaced) 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.

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.
- 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.
- Case studies may be discussed among students, but reports must be individual, original work. Submission will utilize plagiarism checking.

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.

- Possible sources for this topic may include real-world application from current published peer-reviewed journals, case-studies from the text, or sections of from Chapters 6-8 not lectured.
- Each student may choose their topic subject to instructor approval.

- The project paper will be written in report form and 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 student is expected to present their topic before the class. Presentations are expected to be 7-10 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.

Late or Missing Work

- **Assignments (including Homework, Article Summaries, Case Studies, and Quizzes):**
  - Students are expected to turn in assignments on time. Missing work will be given a grade of 0.
  - Assignments may be accepted late in extenuating circumstances only by instructor approval.
- **Tests:**
  - Missed tests may be made up only by instructor approval. Except in extenuating circumstances, late tests will be penalized 10 percent per day until four days are past; at which point, the test will be given a grade of 0.
- **Project submissions:**
  - Projects will not be made up except in extenuating circumstances.

Grading Scheme

Final grades will be assigned according to a standard 10 percentage point scale calculated out of the total points available during the semester (≈750 pts). Percentages will be rounded to the nearest whole percentage when determining final grades.

Extra Credit

- Extra points are built into the course. No additional extra credit work will be granted.

OTHER POLICIES

Classroom Decorum

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.

Attendance

- 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).

Copyright Policy

Ma 390 Fall 2020 Tentative Schedule			
Date	Day	Class	Assignment
Unit 1: Introduction to Linear Optimization (Chapers 1-3)			
T, Aug 18	T	Intro to Lin Op	Read Chap 1 & 2 before Th
Th, Aug 20	Th	Discuss Ch 1 & 2	
T, Aug 25	T	**Ch 3** 3.1-3.3	
Th, Aug 27	Th	3.4-3.5	Article Discussion Board (Ch 2, Th. Sep 3)
T, Sep 1	T	3.6, Discussion	
Th, Sep 3	Th		
T, Sep 8	T	**Unit 1 Test**	Unit 1 Submissions due Mon, Sept 7 • Article Discussion Board (Ch 3) • Unit 1 Homework (Ch 3) • Homework Portfolio (Ch 3) • Unit 1 Case Study
Unit 2: The Simplex Method (Chapters 4-5)			
Th, Sep 10	Th	**Ch 4-5** 4.1-4.2	
T, Sep 15	T	4.3	
Th, Sep 17	Th	5.1	
T, Sep 22	T	4.4	
Th, Sep 24	Th	5.2	
T, Sep 29	T	4.5	Homework Portfolio (Ch3, Sec 4.1-4.4, 5.1-5.2)
Th, Oct 1	Th	4.6, 5.3 Discussion?	
T, Oct 6	T	Discussion	
Th, Oct 8	Th		
T, Oct 13	T	**Unit 2 Test**	Unit 2 Submissions due Mon, Oct 12 • Article Discussion Board (Ch 4) • Unit 2 Homework (Ch 4-5) • Homework Portfolio (Ch3-5) • Unit 2 Case Study
Th, Oct 15	Th	Day of Rest	
Unit 3: Sensitivity, Duality, and Other Topics (Chapters 6-7)			
T, Oct 20	T	**Ch 6-8** 7.1-7.3	
Th, Oct 22	Th	7.4	
T, Oct 27	T	7.5-7.7 Discussion	
Th, Oct 29	Th	6.1-6.3	Article Discussion Board (Ch 7 due Th, Oct 29)
T, Nov 3	T	6.4	Homework Portfolio (Ch 3-5, 7)
Th, Nov 5	Th	6.5-6.6 Discussion	
T, Nov 10	T	Topics in Chapter 8	
Th, Nov 12	Th		
T, Nov 17	T	**Unit 3 Test**	Unit 3 Submissions due Mon, Nov 16 • Article Discussion Board (Ch 6) • Unit 3 Homework (Ch 6-7) • Homework Portfolio (Ch 3-7) • Unit 3 Case Study
Finals Exam, Project, and Presentation			
Th, Nov 19	Th	**Cumulative Exam**	
M, Nov 23	M	**Final 8:00-9:10**	Project and Presentations