IE/MA 4733/6733: Linear Programming

Hugh Medal

Syllabus, Spring 2017

COURSE INFORMATION

Instructor

Hugh Medal
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Teaching Assistant

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Office Hours

The office hours for this course are the following:

- Monday: 10-11:30am (McCain 320B)

- Tuesday and Thursday: 11:00-12:15pm; 2-2:30pm (McCain 260K)

- Wednesday: 10-11:30am (McCain 320B)

- Friday: by appointment

For Dr. Medal's office hours you are welcome to drop in. However, if you wish to reduce/eliminate waiting time, you may wish to schedule an appointment via https://hughmedal.youcanbook.me/.

Course materials

Required textbooks

- "Operations Research – Applications and Algorithms," by Wayne L. Winston, 4th edition, Brooks/Cole-Thomson, Belmon, CA, 2004. ISBN-13: 978-0534380588.

- "Applied Mathematical Programming," by Bradley, Hax, and Magnanti, Addison-Wesley, 1977. Freely available from: http://web.mit.edu/15.053/www/

Prerequisites

MA 3113 – Introduction to Linear Algebra

Course Description

(3) Three hours lecture. Theory and application of linear programming; simplex algorithm, revised simplex algorithm, duality and sensitivity analysis, transportation and assignment problems algorithms, integer and goal programming.

Course Website and Communication

I will use the course website (found via mycourses.msstate.edu) to post assignments, grades, etc. Students will submit their homework to this website. Students should make sure that they receive announcements from the course website (it should automatically go to your MSU email address). Students are also responsible to check their msstate.edu email account.

LEARNING OBJECTIVES

At the end of the course students should be able to:

1. Given a problem description, formulate an LP problem

2. Solve a two-variable LP graphically

3. Formulating large-scale LPs using set and index notation

4. Formulate the following problems as linear programs: absolute value, maximum of variables

5. Given a mathematical program, determine if it is a linear program or not

6. Describe (draw or write out using constraints) the feasible region of a linear program

7. Determine by inspection if an LP is unbounded or infeasible and explain how you know

8. Solve an LP using the simplex method; report the optimal solution and the optimal objective value

   (a) Convert LP to standard form
   (b) Find basic feasible solution
   (c) Solve for max and max problem

9. Given an optimal solution to an LP, classify each constraint as binding or loose

10. Solve an LP with multiple optimal solutions and report all of the optimal solutions

11. Use simplex to determine that LP is infeasible

12. Use simplex to determine that LP is unbounded

13. Solve an LP using the two-phase method; report the optimal solution and the optimal objective value

14. Use the graphical method to do sensitivity analysis

15. Given LINDO output, answer various questions about sensitivity analysis

16. Be able to explain the following concepts given a problem description, linear program, and LINDO output. a. Reduced cost b. Shadow price (dual price) c. Objective function coefficient range d. Right-hand side range

17. Formulate the dual of a given linear program and interpret its variables, objective function, and constraints in economic terms.

18. Formulate and solve the dual of a given linear program. Use this information to answer questions related to sensitivity analysis

19. Use the theorem of complementary slackness to find the optimal solution to an LP and its dual

20. Use weak duality to find a bound on the optimal objective value of the primal

21. Use strong duality to find an optimal objective value to the primal given an optimal solution to the dual

22. Given information about whether a given LP is infeasible or unbounded, determine whether its dual is infeasible or unbounded.

23. Formulate a balanced transportation problem given a problem description

24. For a given transportation problem, use the minimum cost method to find a basic feasible solution

25. Solve a transportation problem using the transportation simplex method

26. Formulate an assignment problem

27. Solve an assignment problem using the Hungarian method

IMPORTANT DATES

See http://www.registrar.msstate.edu/calendars/academic-calendar/ for more details:

- January 13, Last day to drop a course without a grade (5th class day) 5:00 p.m.

- January 16, Holiday

- January 17, Last day to register or add a course (6th class day); Last day to request undergraduate academic forgiveness via myState 5:00 p.m

- February 20, First progress grades reporting deadline

- March 13 – 17, Spring Break – No Classes Scheduled (Dates Subject to Change)

- March 24, Second progress grade reporting deadline

- April 11, Last day to withdraw from University (ten days of classes remaining); Progress grade reporting closes

- April 14, Holiday

- April 26, Classes end

- April 27, Reading Day (No mandatory class assignments, requirements, meetings)

- April 29 & May 5, Make-up days (if needed)

- May 2, Final exam from 12-3pm (see http://www.registrar.msstate.edu/students/schedules/exam-schedule/)

- May 8, Final Grades Due 12:00 noon

COURSE ASSESSMENTS

Student learning will be assessed using the following methods: quizzes (about 10), problem sets (about 5), and a final exam.

Quizzes

All quizzes are closed book and closed notes; a formula sheet is not allowed. Make-up quizzes will only be allowed for university-excused absenses (see below). There will be a quiz almost every week. I expect to give at least 11 of these quizzes of which the best 10 will contribute to your average. Some of the quizzes will include extra problems for graduate students.

On some of the quizzes you may use a computer with a spreadsheet program (e.g., Microsoft Excel). Here are the rules for use of computers:

- Before you start the quiz you must turn off any connection to the outside (e.g., WiFi). You are not allowed to communicate with anyone during the quiz.

- You must have Excel open and maximized on your screen at all times. If we see any other programs open (for whatever reason, even if by accident) you will be penalized.

- Your quiz will be graded as if you did it by hand. Thus, you must show all of your work.

Problem Sets

Take-home assignments will be given about every other week. I expect to give at least 6 assignments. 5 of your best assignments will contribute to your average. They should be typed and submitted online via the course website. **Late assignments will not be accepted**. You are responsible for ensuring that your successfully upload the files in the correct format (.doc, .docx, or .pdf).

Assignments can be done in groups of at most two; however, each student should a copy of the assignment on the course website.

Final Exam

The same format and rules as for quizzes. The final will be given during the final exam period.

Grade Distribution

Assignments	– 40 points (8 points each)
Quizzes	– 30 points (3 points each)
Final	– 30 points

Grading Scale

The following scale represents the minimum percentages needed for you to be guaranteed each letter grade.

A	90.0%
B	80.0%
C	70.0%
D	60.0%

However, I also use gray areas to determine grades. The gray areas are as follows:

A	89.0-89.9%
B	78.0-80.9%
C	67.0-70.9%
D	55.0-60.9%

If you in a gray area, your grade *may* be bumped up based on the following criteria:

- How many gray points did you earn? Gray points can be earned from various activities through the semester such as the syllabus and knowledge quizzes at the beginning of the semester, pop quizzes, etc.

- What is your final exam grade? If your final exam grade is higher than your overall average, I am more inclinded to bump you up.

- How many unexcused absenses did you have?

- Did you put in extra effort to learn the material? (e.g., visit office hours)

- Your class participation (e.g., were you engaged with a good attitude?)

Grading Policies

Late Problem Sets

If you cannot complete a problem set for a University-excused reason (see http://www.policies.msstate.edu/policypdfs/1209.pdf), you will be allowed to promptly submit it as soon as you are able. However, you must have your excuse validated by the Student Affairs office (http://www.saffairs.msstate.edu/).

Missing the Final Exam

If you cannot attend a quiz or the final exam for a University-excused reason (see http://www.policies.msstate.edu/policypdfs/1209.pdf), you will be allowed to reschedule as soon as you are able. However, you must have your excuse validated by the Student Affairs office (http://www.saffairs.msstate.edu/).

Grade Appeals

Grades will be posted on the course web site and updated periodically. It is your responsibility to verify that your grades have been correctly entered. You have *one week* after an assignment or a test is returned to discuss changes in your grade. Note that grade changes may result in an increase or a decrease in your grade.

GUIDELINES

Academic Honesty

We will comply with the MSU Honor Code (http://www.honorcode.msstate.edu/pdf/honor-code.pdf), which requires me to report cases of academic dishonesty (page 8). Examples of academic dishonesty in this class include by are not limited to the following:

- Using unauthorized materials/resources on a quiz/test

- Communicating with people outside the class during a quiz or test

- Communicating or copying work on a quiz/test

- A conversation about an quiz/test between a student who has taken the exam and a student who has not yet taken it

- Copying homework from another student

Students Needing Extra Accommodation

If there are any issues that may affect your learning, please let me know. I would like to make accommodations in any way I can, in collaboration with Student Support Services (SSS) (http://www.sss.msstate.edu/disabilities/). In addition, you may wish to consult with SSS yourself to understand how you can receive help. Students who need academic accommodations based on a disability should visit the Office of Student Support Services, 01 Montgomery Hall, call 662-325-3335, or visit the website at www.sss.msstate.edu. Once you have been approved for special accommodations by SSS, please see me so we can discuss how to best accomodate you.

Title IX

MSU is committed to complying with Title IX, a federal law that prohibits discrimination, including violence and harassment, based on sex. This means that MSU's educational programs and activities must be free from sex discrimination, sexual harassment, and other forms of sexual misconduct. If you or someone you know has experienced sex discrimination, sexual violence and/or harassment by any member of the University community, you are encouraged to report the conduct to MSU's Director of Title IX/EEO Programs at 325-8124 or by e-mail to titleix@msstate.edu. Additional resources are available at http://www.msstate.edu/web/security/title9-12.pdf, or at http://students.msstate.edu/sexualmisconduct/<http://students.msstate.edu/sexualmisconduct/>.

INFORMATION FOR DISTANCE EDUCATION STUDENTS

Taking Quizzes and the Final Exam

- **Proctoring requirements**. Distance students are required to take the final exam via a human proctor (see instructions below). However, they make take quizzes using either a human proctor or they should self proctor (see instructions below). We would prefer that you self-proctor for the quizzes.

- **Instructions for registering your proctor**. At least one week in advance of using a human proctor, the student must submit the proctor form (http://www.bcoeonline.msstate.edu/wp-content/uploads/2016/11/Proctor-Form.pdf) and follow the directions therein. If only one proctor is used for the entire semester, then only one proctor form must be submitted. However, a new proctor form must be submitted for each change in proctor *at least one week in advance of use*. In choosing your proctor, you should find someone who is not related to you and is trustworthy. Examples include your supervisor or someone in Human Resources. If you have a question about whether someone would be an acceptable proctor, you may ask me.

- **Procedure for using a proctor**. Prior to the quiz/exam, we will email a copy of the quiz/exam to your proctor. You will then take the quiz/exam under their supervision. After you complete the quiz/exam, your proctor will scan your work and email it to us. Please be responsible for ensuring that your proctor submits your work to us on time.

- **Instructions for self proctoring**. For this option you will take the quiz on the course website. After starting the quiz, you will have about 15-45 minutes (depending on the length of the quiz) to upload a file containing your answers. Please write out your answers by hand and submit a PDF image of your answers (a scanner is preferable but a scan using a mobile device is ok). If you have any trouble submitting your PDF on the course website, please email it to the TA and explain why you had trouble submitting it.

- **When to take exams**. Distance students are typically expected to take quizzes/exams before the end of two business days after the exam has given in class. For example, if a quiz/exam is given on a Thursday, I would give distance students until Monday at 11:59 pm to take the exam, whether they use a proctor or they self-proctor.

Other

- For office hours, distance students may communicate with me via phone. However, students have found a video chat (e.g., Skype) to be more useful.

- Distance students are expected to keep up-to-date with watching video lectures. A link to the video lectures will be provided on the course website.

- Students can visit www.bcoeonline.msstate.edu to report technical difficulties or to access classroom videos. There is a link for each on the bottom right side of the page.