Math 170: Linear Programming, Fall 2021 (84427)

Instructor: Prof. Coşkun Çetin (pronounced 'Joshkun Chetin')
Zoom Office Hours: M T W Th 2-2:45 pm (or by appointment, if these times don't work for you)
E-mail: cetin@csus.edu
Lectures: T Th 12:00 - 1:15 pm (through Zoom)

Catalog Description: Theory of linear programming, duality, simplex method, integer programming, applications.

Prerequisites: Math 31 and either Math 35 or Math 100.

Textbook: Applied Mathematical Programming by Bradley, Hax, & Magnanti (1977, Addison-Wesley). Its electronic copy is freely available online (e.g. at http://web.mit.edu/15.053/www/AMP.htm). The relevant material/ documents and some other recommended resources will be posted on Canvas.

Material Covered: Most of the material covered will be from the chapters 1-5 and 8 of the textbook, which include simplex algorithm, sensitivity analysis, duality, matrix methods and network models. If time permits, a few selected topics from other chapters may also be introduced.

Course Description: Math 170 is an upper division elective in the mathematics major, but it is also suitable for computer science, engineering, business and economics majors who are interested in practical applications of mathematics. The main subject is linear programming, one of the basic techniques in the science of optimization, which is the determination of the most efficient or least costly way to carry out some process with linear dynamics and linear constraints. Of course, many practical real world problems involve nonlinear dynamics or nonlinear constraints which require technology tools to solve an optimization problem. Sometimes, we are lucky that such nonlinear problems can be reasonably approximated with a linear one, and hence the methods of this course can apply. The primary topics are the simplex algorithm, unboundedness, degeneracy, duality, matrix notation, sensitivity analysis, convex analysis, game theory, and network flow analysis. Although programming appears in the title (for historical reasons), it mainly refers to the algorithmic nature of the methods used. So, this is not a course in computer programming (and no programming background is required). Since several computational tools and programs are used in solving large linear programming problems, we will explore some of the software/ technology tools that are available, including spreadsheets like Excel, programs like Matlab (which is available to all Sac State faculty and students through IRT site – check Software and Tools Catalog), as well as some free online applets/ resources like Wolfram Alpha. Even though most assignments and tests problems will focus on traditional modeling and hand computations, some homework/ project problems will have explicit technology components.

The synchronous Zoom meetings will include both lecture and problem solving parts. Regular class attendance and participation in class discussions are expected but I don't plan to keep attendance after the first week of classes. The Zoom lectures will be recorded and will be available on Canvas. I may also post some short recorded lectures asynchronously. For your questions, you may utilize Zoom office hours posted above (or contact me to schedule another time slot for a virtual or in-person meeting, if you may not make any of them). Moreover, you can utilize our Virtual Math Lab to get assistance from experienced math tutors. More information about this will be posted on Canvas.

Learning Objectives:

- Learn about the wide range of real-world problems to which linear programming can be applied. These include optimal allocation, sequencing, routing, blending, scheduling, project management and network flow problems.
- Learn how to set up these problems as linear programs.
- Learn the simplex algorithm, how it is initiated, and how it terminates. Learn about potential problems such as degeneracy, cycling, and exponential running times and how these are dealt with.
- Learn how to use matrices and linear algebra techniques to express problems in general form and carry out the simplex algorithm.
- Understand duality and how it enhances the study of sensitivity analysis.
- Learn about transportation networks and how the simplex algorithm can be adapted to solve these problems.
- Learn about some technology tools and modern approaches to solve linear programming problems.

GRADE EVALUATION

The letter grade is based on your overall total points earned, and potentially, a curving to your advantage. Roughly speaking, a score of 90%-100% would be an A (A/A-), 80%-89.9% would be a B (B/B-/B+), 70-79.9% would be a C (C/C-/C+), 60-69.9% would be a D (D/D-/D+), and below 60% would F. Your actual letter grade may be better after slight curving (applied to the overall total). Your overall total score/ performance is determined by the scores of HW assignments, quizzes, tests and the final exam as follows:

Homework Sets: Not for grading. At least six homework (HW) sets will be posted but they won't be collected for grading. I encourage you to start working on these assignments shortly after they are posted, and discuss them with your classmates. I will try to give feedback on the HW items by posting solutions or short answers. Note that quiz problems may be similar to the HW exercises. Reviewing material covered and working on homework assignments are very important for the learning process in all math/ stat courses.

Quizzes: 15%. Three quizzes will be given, each before a relatively high-stake test (see below). One of them might be a take-home quiz, while the others are timed in-class assessments (given via Canvas).

Two Tests: 20% + 20% = 40%. These are timed tests which will be given during regular class meeting times, and will be submitted through Canvas. More information about the tests will be posted later.

Group Project: 10%. This is a rather extensive assignment that involves modeling, solutions via technology and interpretation items that you are expected to work collaboratively in groups (up to three students in a group). The project score will be based on correctness of the solutions as well as organization and presentation of the results.

Final Exam: 35%. This is a cumulative exam which is compulsory. It will consist of two parts: In-class portion which will be given during the formal final exam time (see the dates below), and the take-home portion which will be given during the finals week.

It is important for each student to follow the instructions of these grading items, especially about restrictions on collaboration and outside help. If I have serious doubts (with some compelling evidence) regarding unauthorized help/ collaboration for submitted work, I may repeat the quiz/ test, or replace it with an oral quiz/ exam.

Drops: You may drop this course without a W (withdrawal) record by the census date (Monday, September 27th), via MySacState during the first two weeks, and electronically via OnBase platform after that.

DATES

Withdrawals: Withdrawals (drops after the fourth week) require an approved petition form to be submitted electronically (again via OnBase) and signed by the course instructor. Withdrawing from a course after the sixth week (October 8th) requires a more formal petition that describes the reason of the request (circumstances out of control of the student) and signatures of the instructor and some administrators.

Academic holidays: September 6 (Labor Day), November 11 (Veteran's Day) and November 25-26 (Thanksgiving). There is no class meeting or test on these days.

HW Sets: Roughly every other week. Check Canvas frequently on the schedule of HW assignments.

Quizzes: Thursday, September 23th; Thursday, November 4th and Thursday, December 2nd.

Tests: Thursday, October 7th and Thursday, November 18th.

Group Project/ Presentations: TBA (planned for the last two weeks of the classes)

FINAL Exam: 12:45-2:45 pm on Tuesday, December 14th.

Notes:

1. *In principle, this syllabus is tentative and is subject to change. You are responsible for any such changes and class announcements including the ones posted on Canvas or via Zoom recordings. Regular class attendance is crucial but it is not graded. If you anticipate to be absent on an exam day (with a valid reason), you need*

to notify me in advance to make an arrangement for the test (e.g. to take it earlier). If I cannot arrange a make-up exam, then I may consider shifting the weight of a missed test to the final exam.

2. *It is your responsibility to assure that you are qualified to enroll in this course (meeting the prerequisites including completion of a calculus and a linear algebra course). You may be dropped from the course if you don't show up during the first week's lectures, or don't provide a proof of the prerequisites in a timely manner.*
3. *Some of the examples that will be used in lectures may come directly from the textbook or will be similar to those. So, you are expected to read the book or the corresponding summary/ presentation files for the relevant topics. Moreover, a calculator might be useful in the exams and for computations in class (a simple calculator will be sufficient).*
4. *One or more project presentations might fall in the last week of classes though the due date of the project submission would be a bit earlier.*
5. *You might have already got messages about self-attestation/ certification for a COVID vaccination status or an exemption by the September 13 deadline. There is no face-to-face class meeting for Math 170 but some in-person office hours are possible. Please make sure you follow the required protocols if you plan to be on campus to see me (with an appointment) or for any other reason.*
6. *Academic honesty is expected at all times and in all the work you do in class or outside the classroom. Cheating or plagiarism in any work turned in for a grade will result in getting grade zero in that work or failing the course for all the parties involved. Any such incidence will also be reported to the Office of Student Conduct. For more information about university's academic honesty policy, see the following page:* https://www.csus.edu/umanual/student/stu-100.htm
7. *Sacramento State is committed to ensuring an accessible learning environment where course or instructional content are usable by all students and faculty. If you believe that you require disability-related academic adjustments for this class, please immediately contact Services for Students with Disabilities (SSWD) to discuss eligibility. A current accommodation letter from SSWD is required before any modifications, above and beyond what is otherwise available for all other students in this class will be provided. Please discuss your accommodation needs with me early in the semester.*
8. *Your physical and mental health are important to your success as a college student. Student Health and Counseling Services (SHCS) in The WELL offers medical, counseling, and wellness services to help you get and stay healthy during your time at Sac State. Most services are covered by the Health Services fee and available at no additional cost. Moreover, if you get sick or are placed under quarantine during COVID-19 pandemic, you may get in touch with Student Health and Counseling Services (SHCS) for assistance on your physical and emotional health, and for guidance about the next steps. Any such personal information you provide to your instructors may only be shared with SHCH.*
9. *If you are experiencing challenges in the area of food or stable housing, help is just a click, email or phone call away! Sacramento State offers basic needs support for students with challenges in these areas. Please visit the Basic Needs website for details:* https://www.csus.edu/basicneeds/ *. Some more information/ additional links for campus resources will be posted on Canvas.*