UNIVERSITY OF MONTANA

Department of Mathematical Sciences

# M 582
# Optimization

**Course:** M 582 Sec. B01 (CRN 74676) 3 cr., Autumn 2020
Optimization
TΘ 9:30–10:50am in MATH 103
& on Zoom (meeting ID: 914 1600 4285 passcode: 477334)


**Instructor:** Mark Kayll

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hs.umt.edu/math/people/default.php?s=Kayll

**Office:** MATH 209
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**Hours:** TΘ 2:00–2:50pm & by appointment
(*tentative*) (open for all course matters, including DSS accomm.)

**Prerequisites:** students should have background appropriate for graduate-level study of mathematics; Though we begin from first principles, knowledge of linear programming (at the level of M 362) and discrete optimization (M 361) is helpful.

**Text:** B. Guenin, J. Könemann, L. Tunçel *A Gentle Introduction to Optimization*, Cambridge University Press, New York, 2014 [ISBN 978-1-107-65879-0 (paperback)]

**Important Dates:**

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|---|---|
| last day to add w/o instructor consent | Thursday, 27 August (5pm); |
| Labor Day Holiday | Monday, 7 September; |
| last day to drop or select Audit grade option | Wednesday, 9 September (5pm); |
| last day to drop via Add/Δ/Drop link and avoid 'WP' or 'WF' | Wednesday, 21 October (5pm); |
| Election Day Holiday | Tuesday, 3 November; |
| Veterans' Day Holiday | Wednesday, 11 November; |
| last day to add/drop by petition | Wednesday, 18 November (5pm); |
| last class meeting (during finals) | Thursday, 19 November 10:10am–12:10pm. |

**Description:** This is a graduate-level treatment of linear programming and related topics. We cover the basics, starting with the simplex algorithm, which lays the foundation for probing this subject's beautiful theory. At its heart are the Duality Theorem and the Complementary Slackness Theorem. Time permitting, other topics to be considered are geometry and convexity, shortest path problems, bipartite matching, the Max-Flow-Min-Cut Theorem, and applications to discrete optimization and graph theory (via the Integrality Theorem). Against the backdrop of the lectures, that steer the course, students can expect to gain some facility for the topics covered through working exercises and problems. The presentations enrich the course content for the audience and lay a more solid foundation in the selected material for the speaker.

The course should appeal to anyone interested in optimization, especially linear and combinatorial optimization. It could also serve as a basis for deeper studies; e.g., recent results tie the subject to algebraic geometry through study of the so-called 'central curve' and interior-point methods. Finally, students preparing for graduate exams in C&O will benefit from taking this course.

**Accommodation:** The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you have a disability that adversely affects your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. The instructor will work with you and Disability Services to provide an appropriate modification.

**Assessment:** Grades are based on performance on homework and a presentation. There will be up to two (but maybe zero) take-home tests to be counted as part of the HW weight (see below). There are zero in-class tests. Traditional letter grades will be assigned using the +/− system (see *UM catalog* at catalog.umt.edu/academics/policies-procedures/). UM's policy on Incomplete grades will be followed (see *UM catalog*).

**Homework:** Assignments are set regularly, roughly every two weeks. A (possibly proper) subset of the assigned problems will be graded. Students are responsible for compiling their own 'solution sets', comprised of their own submissions, augmented by notes from meetings with other students and with the instructor.

(over)

**Presentations:** Each presentation consists of a class-period lecture scheduled during a regular, or final, class meeting. The content of the presentations should be related to the course content and may be inspired by one or more sections of the text, by related paper(s), or by other related material. Students should schedule their lecture date privately with the instructor early in the semester; time slots are assigned on a first-come, first-served basis. Lecture topics must be approved by the instructor, and students should take the following preparatory steps.

| Step | Timing | Action |
|---|---|---|
| 0 | early in semester | Schedule lecture date with instructor. |
| 1 | 3 weeks prior to lecture | Submit a $\leq$ 1-page typed summary proposal of lecture topic, with references. |
| 2 | 2 weeks prior to lecture | Receive proposal approval or suggested modifications from instructor. |
| 3 | 1 week prior to lecture | Meet with instructor privately for final informal discussion of lecture topic; be prepared to field questions. |

The following weights will be used to determine course grades:

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|---|---|
| Homework/take-home tests | 70%; |
| Presentation | 30%. |

**Teaching modality:** This is a *hyflex* course; i.e., some students attend face-to-face while others join synchronously via Zoom. Class meetings will be recorded on Zoom so that all students can revisit desired segments.

**Moodle pages:** These are located at `moodle.umt.edu/course/view.php?id=33009`. Students should check the Moodle site regularly to stay in tune with the course flow (announcements, homework, etc.).

## General Remarks

**On homework:** Please use complete sentences, proofread, and polish your work prior to submission. You're encouraged to type homework solutions unless your handwriting is clear. You may work with others on homework problems, and you are encouraged to do so; however,

**Solutions should be written down privately in your own words.**

If you use an important idea of someone else, then please acknowledge that person by giving an appropriate citation in your write-up. This professional courtesy will not affect your grade.

**On make-ups:** Since at least your most detrimental assignment is dropped, there are no homework make-ups.

**On deadlines:** Any stated deadlines are firm; please do not ask for extensions. (Violating this request is considered grounds for negative points on the corresponding assignment.)

**On electronic devices:** Cell phones must be silenced during class meetings and office hour visits.

**On coronavirus:** Attendance will be recorded to support contact tracing. All students must follow UM's face covering policy; see `www.umt.edu/policies/browse/facilities-security/covid-19-face-covering-policy`. With mask use required in the classroom, consuming food or beverages is not allowed because these require mask removal.

**On conduct:** All students need to be familiar with the Student Conduct Code; it can be found in the 'A to Z Index' on the UM home page. All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the university.

## Additional References

1. Vašek Chvátal, *Linear Programming*, W.H. Freeman & Co., New York, 1983
[ISBN-13 978-0716715870 (paperback)]
2. Glenn Hurlbert, *Linear Optimization: The Simplex Workbook*, Springer, New York, 2010
[ISBN-13: 978-1461424550]

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Combinatorics is the most fundamental, and hence the most important, branch of mathematics, since it deals with FINITE structures, and the world is finite.
Doron Zeilberger, *Board of Governors Professor of Mathematics*
Rutgers University