Math 4630/6630 * Nonlinear Optimization * Spring 2021

Important information

Prerequisites: Multivariable calculus (e.g., Math 2300) and linear algebra (e.g., Math 2410, 2600 or 2500-2501) are required. Some familiarity with computer programming is expected.

Instructor: Mark Ellingham, SC 1514, phone 615 322 6670, email `mark.ellingham at vanderbilt.edu`.

Online resources: Most class resources will be available from the class Brightspace site.

Classes: Tuesday and Thursday, 9:35-10:50 a.m., Buttrick Hall 305.

Remote participation: Classes will be streamed on Zoom for remote students and those who cannot attend in person. The Zoom link is available on Brightspace. Since the classroom is not large enough to hold everyone, a small number of on-campus students may have to participate remotely at each class. A schedule for this will be distributed.

Students participating remotely are expected to respond to questions and interact with the instructor. They are also encouraged (but not required) to turn on their video. Even turning this on for a few minutes at the start of class will help the instructor connect with students.

Zoom class sessions will be recorded and posted on Brightspace. Distributing these recordings to anyone outside Vanderbilt is not allowed and is considered an Honor Code violation.

Office hours: Tuesday, 11:10 am - 12:00 noon (Zoom and in person), Wednesday, 11:00-11:50 am (Zoom only) and Wednesday, 2:30-3:20 pm (Zoom only), or by appointment at other times. The Zoom link is available on Brightspace. To attend office hours in person (at the scheduled Tuesday time or another time) you must make an appointment.

Textbook: I have not been able to find a book that covers all the course material at an appropriate level. Lecture notes covering much of the material will be posted on the class website, but students should expect to rely on their class notes some of the time. Lecture notes will not be posted until *after* material is covered in class.

References: The following books are useful general references for nonlinear optimization:

- "Numerical Optimization (second edition)" by Jorge Nocedal and Stephen J. Wright, Springer, 2006 (first edition available electronically from library).
- "An Introduction to Optimization (fourth edition)" by Edwin Chong and Stanislaw Zak, Wiley, 2013 (available electronically from library).
- "Practical Methods of Optimization (second edition)" by R. Fletcher, Wiley, 1987 (available electronically from library).

The material in the course will be taught with an emphasis on algorithms. Good sources for a more theoretical approach to optimization are:

- "Convexity and Optimization in R^n" by Leonard D. Berkovitz, Wiley, 2002.
- "Convex Analysis and Nonlinear Optimization: Theory and Examples" by J. Borwein and A. Lewis, Springer, 2000.

Assessment: Assessment for this course will consist of four parts: written problems, a short paper, one midterm test, and a final examination. Your final grade will be calculated from a percentage calculated as follows.

Problems	35%
Paper	12%
Midterm test	20%
Final examination	33%

Graduate credit: Students registered for Math 6630 are expected to produce a more sophisticated paper than students registered for Math 4630.

Assigned problems: Problems will be assigned on a regular basis during class, and (unless a different schedule is announced in class) will be due via Brightspace at the beginning of class on the Thursday of the school week following the week in which they are announced. If you have a good reason for submitting an assignment late, please contact me (in advance if at all possible) to make arrangements. Otherwise, late assignments will receive a mark of zero.

Solutions to problems should be fully explained, using clear English sentences where necessary. Solutions must be typed, although you can include hand-drawn figures or hand-written equations when complicated calculations are required. Solutions should be double spaced (to leave room for comments). Solutions should be uploaded to Brightspace as PDF files.

Some problems will require the use of a computer algebra system, specifically *Mathematica*.

Practice problems: Problems for practice will be given out on a regular basis, and will be discussed in class as time permits.

Paper: Students will be required to complete a short paper of about 2,500 words on an application of optimization theory. A proposal for the paper, worth 2% of the final grade, will be due on Thursday, 4th March. The paper itself, worth 10% of the final grade, will be due on Thursday, 15th April.

The paper should concern an application of optimization theory (preferably nonlinear, but linear optimization may be allowed if you discuss the situation with me), either to a real-world problem or to another mathematical problem.

Midterm test and final examination: There will be one 75-minute in-class test on Thursday, 18th March. Absence from the test will be excused only if authorized in advance by the instructor. In case of an emergency the instructor must be notified before the test begins if at all possible: please phone, and if you cannot reach me, then send an email or leave a message with the math office at (615) 322 6672. If sufficient notice of an absence is given, arrangements will be made for you to take the test early. If this is not possible your final mark at the end of the semester will be prorated to take into account the missed test. Absolutely no makeups will be given after the test. In the event of an unexcused absence, or if the instructor is informed unreasonably late of a forseeable absence, then the mark for the test will be recorded as zero.

There will be a 120-minute final examination at 3 pm on Monday, 3rd May. An alternate examination will not be given.

The test and the final examination will be timed online open-book examinations. Everyone will need to have access to a computer with a camera for these. Both the test and the final examination will contain questions involving proofs, essays, or both, as well as questions requiring computations.

Honor code: The Vanderbilt Honor Code applies as follows. Work on written problems to be submitted, the test or the final examination must be done individually; you may not obtain assistance from any source, with the exception of hints given by the instructor. You may discuss your work on the paper with others, but the final paper must be your own work.

Technology policy: Modern technology is useful but also distracting. Full attention and active participation are expected during class. Therefore, the following are prohibited for students attending class in person: taking of photos or videos, use of earphones or earbuds, use of cellphones for any purpose. Laptop or tablet use for taking notes or other class-relevant activities that are not distracting to other students may be allowed at the instructor's discretion (let me know if you plan to use one regularly); your laptop or tablet must be silent. Other use of laptops or tablets is prohibited. Students requiring special accommodation should discuss their situation with the instructor.

Drop dates: The Open Enrollment Period **for math classes only** ends on Friday 29th January. This is the deadline for students to add a course or to make other changes in YES. Between 30th January and 8th February withdrawals or changes to level or grading status must be completed using an add/drop form. If only the DROP section of the form is filled out, the instructor may sign the form. For any change that involves the ADD section of an add/drop form (whether or not it also involves the DROP section), the student must contact the DUS (John Rafter) or Assistant DUS (Jakayla Robbins). The only change to a math course that will be approved is a change to the level of the course (e.g., switching from Math 1301 to Math 1300 or vice versa).

The last day to withdraw from the class is Thursday 1st April.