ESE 415 Optimization (Spring 2023)
Instructor: Prof. Ulugbek S. Kamilov

Course Website: eigroup.wustl.edu/teaching/ese415-2023
Lecture: Mon & Wed, 10–11:20am, Hillman Hall 60
Tutorials: To be determined

Instructor Team:

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Prerequisites:
Knowledge of concepts from the multivariable calculus, including that of the gradients.
Knowledge of concepts from linear algebra, including eigenvalues & eigenvectors, matrix algebraic operations, and properties of symmetric matrices.

Course Description:
Optimization is a key enabling theory behind the recent innovations in artificial intelligence, machine learning, image processing, digital communications, control and robotics, operations research, and financial engineering. Some of the biggest challenges in these disciplines can be formulated and solved as optimization problems. It is an essential topic for anyone who is seriously interested in computational sciences and engineering. This course gives a rigorous introduction to the fundamentals of nonlinear optimization theory and algorithms. Topics include unconstrained and constrained optimization, convex optimization, iterative optimization algorithms, optimality conditions, and duality theory. Algorithms covered include the gradient and accelerated gradient methods, the Newton method, proximal methods, and penalty methods. Homework assignments emphasize the theoretical understanding as well as the ability to conceptualize and implement optimization algorithms using MATLAB. This will be an in-person only class.

Syllabus:
- Introduction, motivation, and preliminaries
- Optimality conditions for unconstrained optimization
- Convex sets and functions
- Unconstrained minimization algorithms and applications
- Optimality conditions for constrained optimization
• Constrained minimization algorithms and applications
• Lagrangian duality and methods of multipliers

**Grading Policy:**
The course grade will be based on a weighted average of the following components:

- **Homework Assignments (60%):** There will be a total of 6 homework assignments, each consisting of 5 problems. All assignments will be collected and graded using Gradescope. Late submissions will be penalized 20% per day. While students are encouraged to discuss homework problems with classmates, everyone must write and submit their own solutions. There will also be an additional homework (assignment #0), which will not be graded, but is useful as a basic prerequisite check.

- **Midterm (20%):** One in-class midterm exam will take place on **Wednesday, 03/08.** Students will be able to use one sheet of paper with notes on the front and the back.

- **Final (20%):** One in-class final exam will take place on **Wednesday, 04/26.** Students will be able to use two sheets of paper with notes on the front and the back.

**Final course grade will be assigned using the following scale:**

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<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A+</td>
<td>≥ 97%</td>
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<tr>
<td>A</td>
<td>≥ 93%</td>
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<tr>
<td>A-</td>
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<td>B+</td>
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<td>B</td>
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<tr>
<td>B-</td>
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<td>C+</td>
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<td>C</td>
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The **passing grade** is C- or better (≥ 70%)

**Optional Textbooks:**
The lecture notes for the class will be available on the class website. The following textbooks are optional:

- “Mathematics of Nonlinear Programming” by A. L. Peressini
- “Convex Optimization” by S. Boyd and L. Vandenberghe
  - [https://web.stanford.edu/~boyd/cvxbook](https://web.stanford.edu/~boyd/cvxbook)
- “Linear and Nonlinear Programming” by D. G. Luenberger
  - [https://mat.uab.cat/~alseda/MasterOpt/31otrialtext.pdf](https://mat.uab.cat/~alseda/MasterOpt/31otrialtext.pdf)

**Disability:**
Washington University is committed to providing accommodations and/or services to students with documented disabilities. Students who are seeking support for a disability or a suspected disability should contact Disability Resources at 935-4153. Disability Resources is responsible for approving all disability-related accommodations for WashU students. If you have already been approved for accommodations, please inform the instructor within the first two weeks of the semester.