19-685 / 19-785 / 24-685 / 24-785
Engineering Optimization
Syllabus – Fall 2022

Course Information:

Lecture:
- o TR 3:05pm - 4:55pm
- o DH 2302

Instructor:
- o Professor Jeremy Michalek
- o Contact: via Canvas
- o Office Hours: TBD

Teaching Assistant:
- o Johnathan Vicente
- o Contact: via Canvas
- o Office Hours: TBD

Grader:
- o Wangchuan "Bradley" Feng
- o Contact: via Canvas

Textbook:
- o Papalambros, P.Y. and D.J. Wilde "Principles of Optimal Design," Third Edition, Cambridge University Press.
- o A digital version of second edition, available for free from the library, is an adequate substitute. https://doi-org.proxy.library.cmu.edu/10.1017/CBO9780511626418. If you use the second edition, check the table of contents for the 3rd edition to find the corresponding chapter or section for each reading.

Website: https://canvas.cmu.edu

Course Description:

This course introduces students to 1) the process of formally representing an engineering design or decision-making problem as a mathematical problem and 2) the theory and numerical methods needed to understand and solve the mathematical problem. Model construction and interpretation are explored through study of model boundedness, sensitivity analysis, metamodeling, constraint activity, and the use of engineering examples for exploring alternative formulations and interpretation of results. Theoretical topics focus primarily on nonlinear programming, including necessary and sufficient conditions for optimality and numerical methods. Additional topics such as mixed-integer programming, convexification, global optimization, decomposition, and stochastic methods such as genetic algorithms are also discussed. MATLAB is used in homework assignments for visualization and algorithm development, and students apply theory and methods to a topic of interest in a course project. Assumes fluency in calculus and linear algebra with prior programming experience. 4 hrs. lec. Prerequisites: None

Course Structure:

This course covers theory of nonlinear optimization at a level appropriate for informed engineering application. We will spend roughly the first half of the course studying theory and methods in enough detail to make you an informed user of optimization solvers. The second half of the course focuses more on practical issues and methods beyond nonlinear programming, and it involves a project where students apply theory to propose, model, and solve an optimization problem of interest. Students enrolled in 19-785 or 24-785 will complete all aspects of the course. Students enrolled in 19-685 or 24-685 will complete all aspects of the course other than the project.

Grading:

Final grades will be calculated as a weighted average of exams, problem sets, project assignments, and in-class assignments. Weighting is expected to be approximately as listed below; however, the instructor reserves the right to adjust weighting if needed to better reflect the balance of work in the course.

- Problem Sets 40%
- Exams 30%
- Project Proposal 5%*
- Final Project Report 20%*
- In-class Assignments 5%

*For students enrolled in a x-685 course number, the project proposal and final project report are not applicable, and the remaining assignments each hold 4/3 of the weight shown.

Expectations:

- **Lectures:** Students are expected to attend lecture on time. The course is designed for synchronous learning, and many lecture periods will involve in-class work and discussions with the instructors and other students. If you have challenges that prevent your participation at the course time, please talk to the instructor.
- **Technology Requirements:** Each student needs access to a computer with MATLAB and Excel installed (available through CMU computing) in order to complete assignments. Most lectures will be held in person; however, there will be a few classes that will take place online, and team meetings and office hours will take place online. Each student needs a computer or tablet with a camera and Zoom software installed to participate in the remote class lectures, office hours, and team meetings.
- **Policy on Collaboration:** Students are encouraged to discuss the course material and challenges or difficulties with the problem sets with one another, and Piazza will be used to help facilitate discussions; however, each student must complete each problem set individually and submit individual work. Copying work is considered cheating.
- **Project Work:** Student projects will be completed in teams. Students are expected to work together to scope the problem, resolve issues, and interpret results, and each team will submit a single project report and a confidential peer evaluation of teammate performance. Individual grades will be assigned based on overall report quality and satisfaction of requirements as well as peer evaluations and instructor experience with team members during team meetings.
- **Policy on Recordings:** Any online lectures will be recorded and available to students for course use only. These recordings are covered under the Family Educational Rights and Privacy Act (FERPA) and must not be shared with any third-party audience (those not registered or associated with the course-section). Breakout room interactions and office hours will not be recorded.
- **Policy on Academic Integrity:** To maintain a professional and respectful environment focused on learning, the instructor will give students the benefit of the doubt that they aim to put forth honest effort and submit original work in an effort to learn, practice, and develop skills and experience needed for future careers. As such, plagiarism and cheating will not be tolerated. Any student caught cheating or submitting plagiarized work will fail the course and be reported to the Dean of Students for further action. Students are expected to know what constitutes plagiarism and to clearly cite any content taken from another source. For details about what constitutes plagiarism, see https://plagiarism.iu.edu/certificationTests/.
- **Policy on Late Assignments:** Student problem set solutions should be submitted to Canvas before the assignment deadline. Official problem set solutions will typically be made available 24 hours after the submission deadline, unless otherwise indicated, and late assignments will not be accepted for partial credit once solutions are posted. Assignments submitted in the grace period after the deadline

but before solutions are released will be docked one letter grade (10%). In special cases of severe medical or family situations, students should approach the instructor in advance.

- **Policy on Email and Discussion Boards:** Please use Canvas for all course communication, rather than email. Due to the large volume of email the instructor receives, questions sent by email may be misplaced or overlooked. Students should use Piazza for course questions, comments, and requests unless the issue is of a private nature, in which case Canvas's email option may be used. The instructor and TA will also be available to answer questions during office hours.

- **Student Well-Being:** We aim to challenge you in this course and help you develop skills and grow without compromising your ability to have a healthy and balanced life. Take care of yourself and do your best to maintain a healthy and balanced lifestyle this semester. A certain, manageable amount of stress may be expected when challenging yourself, but if you are experiencing excessive stress, anxiety, or depression, the university has resources that may be helpful, including the Counseling and Psychological Services (CaPS) [412-268-2922 http://www.cmu.edu/counseling/] and the Re:solve Crisis Network [888-796-8226].

- **Diversity and Inclusion:** Our goal is that all of our diverse students are served well by this course and that the course maintains a respectful, welcoming, and inclusive approach. If you observe incidences of intentional or unintentional bias or discrimination, we encourage you to raise the issue with the instructors, with the department, college, or university ombudsman [EPP: Baruch Fischhoff baruch@cmu.edu 412-268-3246; CMU Holly Hippensteel hbh@andrew.cmu.edu, 412-268-2075], with the Center for Student Diversity and Inclusion [https://www.cmu.edu/student-diversity/] and/or to Report-It at reportit.net [username: tartans, password: plaid].

- **Accommodations for Students with Disabilities:** If you have a disability and have an accommodations letter from the Disability Resources office, discuss your accommodations and needs with the instructors as early in the semester as possible. We will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, you can contact them at access@andrew.cmu.edu.