Math 453: Numerical Optimization

Spring 2022

Instructor:	Dr. Stathis Charalampidis	**Office:**	25-319 (Faculty Offices East)
Email:	echarala@calpoly.edu	**Phone:**	(805) 756-2465

Course Web Page: https://www.egcharalampidis.com/teaching/453_S22/math_453_S22/

Class Meetings:

- MTRF: 07:10-08:00am (38-218)

Office Hours: T 12:00-1:15pm and R 12:00-1:15pm, or by appointment.

Required Textbook:

- *An Introduction to Optimization* (4th edition), Authors: Edwin Chong and Stanislav Żak, Publisher: John Wiley & Sons, 2013.

Additional Reference:

- *Numerical Optimization* (2nd edition), Authors: Jorge Nocedal and Stephen Wright, Publisher: Springer, 2006.

Objectives: This course is the third part of the Numerical Analysis sequence (Math 451-Math 452-Math 453) offered at Cal Poly San Luis Obispo. It deals with the development of numerical methods for selecting the "best" decision of an *objective function.* **Optimization** problems arise in many scientific fields and applications, including (but not limited to) aero-space engineering (for finding the optimal trajectory for an aircraft or computing the optimal shape of an automobile), finance (to maximize expected return while maintaining an acceptable level of risk during an investment), materials science (for designing energy harvesters by maximizing energy conversion), as well as computational physics and applied mathematics. In this course, we will discuss about the foundations of numerical optimization such as unconstrained optimization, linear programming as well as nonlinear unconstrained optimization. Alongside the theory, we will gain practical programming experience in implementing some of the algorithms using MATLAB, which will be taught through increasingly complex codes over the quarter, with examples in class and homework assignments. A detailed course outline containing the learning objectives for this class may be found at

<div align="center">

https://content-calpoly-edu.s3.amazonaws.com/math/1/documents/453.pdf

</div>

Class Material by Topic: During the quarter, we will cover the following topics from the main textbook:

- Mathematical review (briefly)

- Unconstrained optimization (line search algorithms; Newton's and Quasi-Newton's methods; global search algorithms)

- Linear programming (simplex method; integer linear programming)

- Constrained optimization (Convex optimization problems; Lagrangian algorithms and penalty methods)

Course Prerequisites: Math 306 and Math 451.

Programming Prerequisites: Introductory college-level programming course. It should be noted that **MATLAB** will be used in class and for homework assignments. Of course you can use **any** programming language such as Python, Fortran, C (or C++), and so on. There are a few PDF files and links for help with MATLAB on the course web page.

Homework and Exams: There will be (almost) weekly **written** homework assignments including **computational tasks**. For the latter, you will have to include/attach your codes in your homework. Please make sure you include as many **comments** as possible in your codes such that they could be read and easily understood. For a complete list of all homework assigned to date, please visit the Canvas page for the course. Each assignment will consist of a

group of problems and your task will be to write up solutions for each one and develop codes when the question is asking for doing so. Please keep in mind that you will be rewarded not only for getting a correct answer but equally importantly for the structure and presentation of your work. Finally, struggling through a question in the homework and most particularly in a computational/programming task is not something unusual. Please make sure you start developing your codes way in advance in order you to check and debug your programs.

There will be **one in-class exam** and **one cumulative final**. For their schedule, see below the "Important Dates" section of this document.

Note that no makeup midterms will be given. In addition, further details about the policies of the final exam can be found by visiting the link:

<p align="center">https://academicprograms.calpoly.edu/content/academicpolicies/final-exams</p>

Important Dates:

> César Chavez's Birthday .... Thursday, March 31
> Midterm .... Friday, May 6
> Memorial Day .... Monday, May 30
> Final Exam .... Monday, June 6, 7:10-10:00am

Grading Policy: Your final grade in this course is computed according to:

> Homework 40%
> Midterm 30%
> Final Exam 30%

Exams and Class Policies:

- All exams will be closed-book. Exams are primarily based on the material we cover in class and the homework.

- Please go through the cheating and plagiarism procedures by clicking here.

- You are respectfully asked for turning off your cell phones during class time and exams.

- **Attendance is mandatory**. However, an **excused absence** can be allowed only if the reason for your absence falls into any of the categories listed in the following page:

<p align="center">https://academicprograms.calpoly.edu/academicpolicies/class-attendance</p>

Please inform me as soon as possible if you are seeking to make up missed work pursuant to the excusable reasons listed in the url above.

Students with Disabilities: The University provides disability-related support services to qualified students through the Disabilities Resource Center (DRC). If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both me and the DRC (124-119) at (805) 756-1395, as early as possible in the term. In addition, and for your convenience, their website is https://drc.calpoly.edu/. Note that use of DRC services including testing accommodations requires prior authorization by the DRC and compliance with approved procedures. **Make sure you initiate any needed arrangements well in advance of an exam date**.

Diversity and Inclusion: I am fully committed to an academic environment that is free of bias against any group and I firmly believe in the value of diversity in people and ideas. My ultimate goal is to establish that this class is a welcoming environment to every-one regardless of gender identity, sexual orientation, race, ethnicity, or religious identity. The University and I do not tolerate discrimination. Please feel comfortable coming to me or an administration if at any point you ever feel uncomfortable for any reason.