ME/AER 647 Syllabus

Hasan A. Poonawala
Spring 2025

Contact Information

Instructor:	Dr. Hasan A. Poonawala
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Office hours:	TBD

Course Information

Time & Location Mon, Wed & Fri 11:00am - 11:50am
Physical: F Paul Anderson Tower (FPAT) 253

Course Delivery: The class will be in-person.

Course Description
The objective of this course is to teach the fundamentals of continuous optimization and how to use it to solve engineering problems. The course will cover foundational algorithms for solving mathematical optimization problems. A brief introduction to mixed integer programming, non-smooth optimization, and stochastic gradient descent will be included. We will look at convergence properties of some algorithms applied to suitable optimization problems. The course will discuss best practices for combining engineering goals, optimization problem formulation, and software implementations.

Course Topics
Differentiable Unconstrained Problems, Gradient Descent and variants, Newton Methods and variants, Constrained Optimization, Linear and Quadratic Programs, Duality and Dual Optimization Problems, KKT Conditions, Convex Optimization, Simulated Annealing, Genetic/Evolutionary Algorithms (guest lecture), Stochastic Gradient Descent, Introduction to Integer Programming and non-smoothness, Applications and Problem Transcription.

Prerequisites
Understanding of Linear Algebra (rank, nullspace, matrix norms, eigenvectors, subspaces), understanding of multivariable calculus (gradients of vector-valued functions), and ability to write programs in at least one programming language (eg. `Python`, `Julia`, `Matlab`).

Materials
Course content is largely based on material from the following <u>reference texts:</u>

- *Numerical Optimization* by Nocedal and Wright. Available for free through UK Library Infokat.

- *An introduction to Optimization* by Chong and Zak. Available for free through UK Library InfoKat

- *Convex Optimization* by Boyd and Vanderberghe. Available for free here.

Student Learning Outcomes
After completing this course, the student will be able to

1. transform engineering problems involving computation into optimization problems.
2. classify optimization problems.
3. choose algorithms for solving optimization problems.
4. modify algorithms to improve the quality of the solution.
5. formulate the dual optimization problem given the primal problem.
6. solve optimization problems using open-source software programs.
7. interpret the information provided by optimization solvers regarding a solution.

Workload
Students can expect to spend at least 9 to 12 hours per week (outside of normal course meetings hours) working on homework and studying course material.

Office Policy
I encourage students to seek help if they have questions. I am available for technical questions during my office hours. For discussions related to other issues, please set up an appointment with me.

Email Policy
I will respond to relevant emails within 48 hours, between 8am and 6pm.

When sending an email, write the subject as follows:
[ME647] (Summary of Issue)

Course Assessment
Course assessment will be based on two mid-term exams, one final exam or course project, and programming/paper assignments and in-class assessments (quizzes). Exams will be in person and may involve programming.

Type	Weight	Date
Homework	10%	
Quizzes	10%	
Mid-term Exam	20%	March 12
Mid-term Projects	40%	Feb 10-21, Mar 24-April 04
Final Exam/Project	20%	May 05

The semester begins with 0 entered for all evaluations. Your predicted grade will increase as you earn points on assignments and exams. Course assessment procedures may change during the semester.

Midterm and Final Exams
Midterm and Final Exams will be held in-person. Arrangements for proctoring will be announced closer to the exam dates.

No make-up exams will be given except in the case of an excused absence (please see the Excused Absences section of this syllabus). In this case, the student must make a reasonable attempt to notify the instructor before the scheduled exam is missed.

Unless otherwise stated, exam problems are graded based on the correctness of your work, not just the final answer. For example, a correct final answer without any work may receive zero credit.

If you want to have an exam re-graded, then you must submit a re-grade request, which consists of the graded exam and a typed letter explaining why you request a re-grade. A re-grade request must be submitted within 2 weeks of the date that graded exams were distributed to the class. If you request a re-grade, then the entire exam is re-graded.

Homework Assignments
TBD

Course Grading (Tentative)

Cumulative Score	Letter Grade
90-100%	A
< 90%	B
< 80%	C
< 70%	D
< 60%	E

Academic Integrity
Per University policy, students shall not plagiarize, cheat, or falsify or misuse academic records. Students are expected to adhere to University policy on cheating and plagiarism in all courses.

UK policies on academic offenses are available at this UK webpage.

Attendance Policy
Attendance will **not** be taken during normal lecture periods.

Classroom Conduct
Students are expected to conduct themselves in a professional and courteous manner.

Class Recording Notification
The University of Kentucky Student Code of Conduct defines Invasion of Privacy as using electronic or other devices to make a photographic, audio, or video record of any person without their prior knowledge or consent when such a recording is likely to cause injury or distress.

Meetings of this course may be recorded. All video and audio recordings of lecturers and class meetings, provided by the instructors, are for educational use by students in this class only. They are available only through the Canvas shell for this course and are not to be copied, shared, or redistributed.

As addressed in the Student Code of Conduct, students are expected to follow appropriate university policies and maintain the security of linkblue accounts used to access recorded class materials. Recordings may not be reproduced, shared with those not enrolled in the class, or uploaded to other online environments.

If the instructor or a University of Kentucky office plans any other uses for the recordings, beyond this class, students identifiable in the recordings will be notified to request consent prior to such use. In anticipation of such cases, students may be asked to complete an "authorization of use" form by a faculty member.

Video and audio recordings by students are not permitted during the class unless the student has received prior permission from the instructor. Any sharing, distribution, and or uploading of these recordings outside of the parameters of the class is prohibited. Students with specific recording accommodations approved by the Disability Resource Center should present their official documentation to the instructor.

All content for this course, including handouts, assignments, and lectures are the intellectual property of the instructors and cannot be reproduced or sold without prior permission from the instructors. A student may use the material for reasonable educational and professional purposes extending beyond this class, such as studying for a comprehensive or qualifying examination in a degree program, preparing for a professional or certification examination, or to assist in fulfilling responsibilities at a job or internship.

Excused Absences

The complete academic policies regarding excused absences can be found in the Senate Rules under "Excused Absences." The Senate Council has interpreted excused absences for the Fall 2020 semester to include an excuse from required in-person interactions if the student has been directed to self-quarantine by the University (including its app), a medical professional, public health professional, or government official.

Per Senate Rule 5.2.4.2, students missing any graded work due to an excused absence are responsible for informing the Instructor of Record about their excused absence within one week following the period of the excused absence (except where prior notification is required).

Make-up Exams

Make-up exams for excused absences will be held in the last week before finals. The syllabus will include all topics covered during the course.

Accommodations due to disability

If you have a documented disability that requires academic accommodations, please arrange to meet with me as soon as possible during scheduled office hours. In order to receive accommodations in this course, you must provide me with a Letter of Accommodation from the Disability Resource Center (DRC).

Academic Policy Statements

A full list of UK academic policies is available at this UK webpage.

Resources

The University of Kentucky and the Pigman College of Engineering offer a wide range of student support services. Below are links to a few good starting points for finding the support you may need for success in your studies:

- Center for Support and Intervention: link

- UK Student Success services page: link

- James and Gay Hardymon Center for Student Success link

- Disability Resource Center: link

- Tutoring and Coaching: link and link