

ECE 733
Non-Linear Optimization for Engineers

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR DESCRIPTION

This course addresses different concepts in nonlinear optimization with a special focus on electrical applications. Starting with classical optimization approaches and single dimensional methods, we move to cover unconstrained and constrained multidimensional optimization. Both gradient-based and value-based optimization approaches are covered. The course also addresses areas of research relevant to electrical engineering. These include space mapping (SM) optimization, global optimization approaches such as particle swarm optimization (PSO), and adjoint variable methods (AVM). The examples and projects mainly focus on applications relevant to electrical engineering.

SCHEDULE And MODE OF DELIVERY

The material for this course will be delivered through a mixture of online videos, textbook readings, live online lectures and tutorials (which are also recorded), and virtualized laboratories and projects. The platform for each component is noted at the end of each line.

Lecture: Mondays, 9:00 am -12:00 pm

INSTRUCTOR

Dr. Mohamed Bakr
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Office: ITB-A111
Phone: 905-525-9140 ext. 27352
Office Hours: TBD

Please note that during the university closures due to Covid-19 in the Winter Term, instructors will not be in their offices. Please see the course website for clarification on their availability.

COURSE WEBSITE/S

<http://avenue.mcmaster.ca>

COURSE OBJECTIVES

By the end of this course, students should be able to:

- understand the difference between different optimization problems
- understand how different optimization algorithms are executed
- understand the difference between optimization methods and their limitations
- evaluate first and higher order sensitivities using finite differences and using adjoint variable methods
- utilize surrogate model optimization methods such as Space Mapping in solving practical problems
- write MATLAB/Python codes that implement different optimization algorithms
- apply optimization methods to different areas of their research

ASSUMED KNOWLEDGE

Basic knowledge of calculus and vector analysis

COURSE MATERIALS

Textbooks:

Singiresu S. Rao, Engineering Optimization Theory and Practice, Third Edition, John Wiley and Sons

Jorge Nocedal and Stephen Wright, Numerical Optimization, Second Edition, Springer

Other:

Collection of research papers

COURSE OVERVIEW

Week	Topic
1	Introduction
2	Classical Optimization Approaches
3	One Dimensional Search
4	Unconstrained Optimization
5	Constrained Optimization
6	Sequential Quadratic Programming
7	Linear Programming
8	Convex Optimization
9	Global Optimization Approaches
10	Space Mapping Optimization
11	Adjoint Variable Methods
12	Optimization Methods for Machine Learning
13	Applications

A more detailed time line is available on the course web site.

At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

ASSESSMENT

Component	Weight	Due Date
Project 1	25%	
Project 2	25%	
Project 3	25%	
Project 4	25%	
Total	100 %	

Late submissions of assignments or project report are subject to 20% penalty per day (less than one day is counted as one day).

CONDUCT EXPECTATIONS

As a McMaster graduate student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

ACADEMIC ACCOMMODATIONS OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services \(SAS\)](#) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to

<http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf>.

www.eng.mcmaster.ca/ece