



Faculty of Engineering
Department of Mechanical Engineering
COURSE OUTLINE

MECH 580 A03 – Engineering Optimization

Term – Summer 2022 (202205)

Instructor	Office Hours
Dr. Abdolrasoul Sohouli	Days: Thursday Time: 6:30 – 7:30pm
E-mail: sohouli@uvic.ca	Location: Zoom

Instructor in Charge
Dr. Afzal Suleman
E-mail: suleman@uvic.ca

LECTURE DATE(S)

Section: A03 /CRN30637	Days: WF	Time: 18:00-19:20	Location: Online
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TA Name	E-mail	Office
TBD	TBD	TBD
TBD	TBD	TBD

ONLINE LEARNING, TEACHING, AND TOOLS

This course will be taught entirely online, making use primarily of Brightspace and Zoom (and maybe other tools).

This online format is new for many students and instructors. As we move through term, we will learn what works, and what doesn't, and adjustments to the course outline might be necessary. Possible changes will be discussed.

Lectures:

Lectures will be live during regular lecture times. Synchronous (live) lectures will be recorded for use by students enrolled in this course, but these recordings will not be used beyond the current section of the course. Please be aware that student participation, such as when asking questions in class, will be captured as part of these recordings.

Office Hours:

Online office hours will use Zoom. Times will be announced at the beginning of the term. You can also contact me through e-mail for appointments.

Tools required:

- Desktop or Laptop Computer with webcam/microphone/speakers/headsets for online lecture & tutorials (worst case a smartphone will do)
- Scanner (desktop or phone-based)
- Printer (useful but not mandatory)
- Software installed on your computer:
 - Web browser to be able to access/run Zoom, Brightspace, etc.
 - Pdf viewer
 - Excel, Word, etc. might be useful as well
 - MATLAB
 - MAPLE (optional)

Please make yourself familiar with Zoom, which we will use for live interaction in tutorial, office hours, etc:

<https://www.uvic.ca/systems/services/avmultimedia/zoomvideoconferencing/index.php>

COURSE OBJECTIVES:

Essentially, every engineering problem can be formulated as an optimization of some function under some set of constraints. The task of finding an optimal solution can often be cast in the form of finding a point, at which the objective function reaches its minimum (or, alternatively, maximum) value. Naturally, how tractable and realizable the above task is, depends on the properties of the cost function at hand as well as its domain and range. Accordingly, the fundamental objective of this course is to introduce some core concepts in optimization theory along with its relevant numerical techniques.

To this end, students will gain valuable background and knowledge in optimization methods applicable to a wide range of engineering problems along with experience in solving optimization problems of their own field of interest. We will use MATLAB in the course, motivating the analysis and algorithms with a number of case studies. Topics covered will be selected from the following: linear and nonlinear optimization methods, algorithms for constrained and unconstrained problems, and global optimization methods such as Genetic Algorithm (GA) and Particle Swarm Optimization (PSO).

The goal of the course is to provide the student with knowledge and experience in the optimization methods with application to engineering. This course will cover optimization methods emphasizing how to formulate and solve engineering problems. The student will also gain valuable experience in choosing of the most suitable optimization method for the most varied optimization problems.

LEARNING OUTCOMES: At the end of this course, students will be able to:

1. Describe core optimization techniques, e.g., linear programming, nonlinear programming and more.
2. Discuss the pros and cons of the optimization approaches.
3. Identify real-world problems that could be solved using optimization techniques.
4. Explain how to define design variables, objective function and constraints of the optimization problem.
5. Use non-gradient and gradient based optimization approaches.
6. Use various computational algorithms for unconstrained optimization, including steepest descent and conjugate-direction methods.
7. Implement computer programs of optimization algorithms for unconstrained optimization.
8. Use various computational algorithms for constrained optimization, including penalty function methods, augmented Lagrange multiplier, and sequential quadratic programming.
9. Use global optimization approaches for unconstrained and constrained optimization problems.
10. Solve real-world optimization problems using solvers, and other optimization software.

Weight & Date(s) of Assessments:	Weight	Date
Project:	30%	August 10
Mid-terms	50%	June 10 (18:00-19:30) / July 15 (18:00-19:30)
Assignments	20%	TBD

NOTES

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

COURSE LECTURE NOTES

Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

Course Schedule

Module	Topics	Date/Week
1	Optimization fundamentals and Graphical Optimization	May 4
2	Optimum Design Concepts – Duality and optimality	May 6
3	Optimum Design Concepts – KKT conditions	May 11
4	Linear Programming –Simplex method	May 13
5	More on Linear Programming – Simplex method	May 18
6	One dimensional problem– Newton method, Bisection method	May 20
7	More on One dimensional problem– Polynomial approximation, Golden section	May 25
8	Unconstrained Optimization– Non-gradient methods– Random walk	May 27
9	Unconstrained Optimization– Non-gradient methods– Pattern search, Powell’s Method	June 1
10	Unconstrained Optimization– Gradient based methods–Steepest descent method, Conjugate gradient method	June 3
11	Unconstrained Optimization– Gradient based methods–Davidon-Fletcher-Powell Method, Broydon-Fletcher-Goldfarb-shanno method	June 15
12	Constrained Optimization– Indirect methods –Exterior Penalty Function (EPF)Method, Augmented Lagrange Multiplier (ALM) Method	June 17
13	Constrained Optimization–Direct methods – Convex Approximation Methods – Sequential Linear Programming (SLP)	June 22
14	Constrained Optimization–Direct methods – Convex Approximation Methods – Sequential Quadratic Programming (SQP), Method of Moving Asymptotes (MMA)	June 24
15	Global Optimization– Genetic Algorithm (GA)	June 29
16	Global Optimization– More on Genetic Algorithm (GA)	July 6
17	Global Optimization– Particle Swarm Optimization (PSO)	July 8
18	Global Optimization– More on Particle Swarm Optimization (PSO)	July 20
19	Global Optimization– Simulated Annealing	July 22
20	Introduction of a neural network-based optimization approach	July 27

General Information

Note to Students: Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Assistant to the Chair to set up an appointment.

Centre for Accessible Learning (CAL) <https://www.uvic.ca/services/cal/>

Accommodation of Religious Observance (AC1210) Read it [here](#)

Discrimination and Harassment Policy (GV0205) Read it [here](#)

Sexualized Violence Prevention and Response at UVic:

UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the university defines sexualized violence and its overall approach by visiting <https://www.uvic.ca/sexualizedviolence/>. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support please contact the sexualized violence resource office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:

Where: Sexualized violence resource office in EQHR; Sedgewick C119

Phone: 250.721.8021

Email: svpcoordinator@uvic.ca

Web: <https://www.uvic.ca/sexualizedviolence/>

Office of the Ombudsperson:

The Office of the Ombudsperson is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations.

Phone: 250-721-8357

Email: ombuddy@uvic.ca

Web: <https://uvicombudsperson.ca/>

Electronic devices in labs and lectures: No unauthorized audio or video recording of lectures is permitted.

Electronic devices in midterms and exams: Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests unless explicitly authorized.

Faculty of Engineering, University of Victoria Standards for Professional Behavior

It is the responsibility of all members of the Faculty of Engineering, students, staff, and faculty, to adhere to and promote standards of professional behavior that support an effective learning environment that prepares graduates for careers as professionals...

You are advised to read the Faculty of Engineering document [Standards for Professional Behavior](#) which contains important information regarding conduct in courses, labs, and in the general use of facilities.

Engineering Students' Society

The Engineering Students' Society (ESS) serves all students registered in an Engineering degree program. For information on ESS activities, events and services navigate to <http://www.engr.uvic.ca/~ess>

Grading System

The University of Victoria follows a percentage grading system in which the instructor will submit grades in percentages. The University will use the following Senate approved standardized grading scale to assign letter grades. Both the percentage mark and the letter grade will be recorded on the academic record and transcripts.

Read the policy [here](#)

Course Experience Survey (CES)

We value your feedback on this course. Towards the end of term you will have the opportunity to complete a confidential course experience survey (CES) regarding your learning experience. The survey is vital to providing feedback to me regarding the course and my teaching, as well as to help the department improve the overall program for students in the future. When it is time for you to complete the survey, you will receive an email inviting you to do so. If you do not receive an email invitation, you can go directly to the <http://ces.uvic.ca>

You will need to use your UVic NetLink ID to access the survey, which can be done on your laptop, tablet or mobile device. I will remind you closer to the time, but please be thinking about this important activity, especially the following three questions, during the course.

- What strengths did your instructor demonstrate that helped you learn in this course?
- Please provide specific suggestions as to how the instructor could have helped you learn more effectively.
- Please provide specific suggestions as to how this course could be improved.

Attendance

Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time...

An Instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations.

Students who do not attend classes must not assume that they have been dropped from the course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course. Read the policy [here](#)

Academic Integrity

Academic integrity is intellectual honesty and responsibility for academic work that you submit individual or group work. It involves commitment to the values of honesty, trust, and responsibility. It is expected that students will respect these ethical values in all activities related to learning, teaching, research, and service. Therefore, plagiarism and other acts against academic integrity are serious academic offences.

The responsibility of the institution Instructors and academic units have the responsibility to ensure that standards of academic honesty are met. By doing so, the institution recognizes students for their hard work and assures them that other students do not have an unfair advantage through cheating on essays, exams, and projects.

The responsibility of the student Plagiarism sometimes occurs due to a misunderstanding regarding the rules of academic integrity, but it is the responsibility of the student to know them. If you are unsure about the standards for citations or for referencing your sources, ask your instructor. Depending on the severity of the case, penalties include a warning, a failing grade, a record on the student's transcript, or a suspension.

It is your responsibility to understand the University's policy on [Academic Integrity](#)

Equality

This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Centre for Accessible Learning (formerly the Resource Centre for Students with a Disability) located in the Campus Services Building.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.