



Course Outline

Instructor

- Joe LoVetri, P.Eng.
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Office Hours

- By appointment

Teaching Assistant

- TBA

Contact Hours

- 4 credit hours
- Lectures:
3 hours x 12 weeks = 36 hours

Prerequisites:

- MATH 3132 Engineering
Mathematical Analysis 3

Traditional Territories Acknowledgement

The University of Manitoba campuses and the Department of Electrical and Computer Engineering are located on original lands of the Anishinaabeg, Cree, Ojibwe-Cree, Dakota, and Dene peoples, and on the homeland of the Red River Métis.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of Reconciliation and collaboration.

ECE 4860 T14 – Optimization Techniques

Winter 2024

Course Objectives

To introduce mathematical optimization techniques that can be used for the solution of engineering design and inverse problems. The formulation of the various types of multivariable optimization problems amenable to computer solution. To study and implement some relevant algorithms to solve such problems.

Course Content

Most of the following topics will be covered:

- Mathematical concepts and formulation of multivariable optimization.
- Classical methods of unconstrained optimization.
- Zero, first and second order direct search techniques and algorithms for unconstrained optimization.
- Linear programming.
- Constraints - equality and inequality, optimality criteria.
- Numerical techniques for constrained optimization.
- Neural Networks as an optimization problem.

If time permits:

- Game theory as an optimization problem.
- Strategies for global optimization.
- Minimization of functionals.

Textbook

E.K.P. Chong, S.H. Zak, *An Introduction to Optimization*, 4th Edition, John Wiley and Sons, Inc., 2013.

Recommended Reference Books

1. S. S. Rao, *Engineering Optimization: Theory and Practice*, 4th Edition, John Wiley & Sons, 2009.
2. A. Beck, *Introduction to Nonlinear Optimization Theory, Algorithms, and Applications with MATLAB*, SIAM, 2014.
3. R. K. Arora, *Optimization: Algorithms and Applications*, Chapman and Hall/CRC, 2015.
4. L.E. Scales, *Introduction to Non-Linear Optimization*, Springer-Verlag, 1985.
5. D.G. Luenberger, *Optimization by Vector Space Methods*, John Wiley & Sons, 1969.

Learning Outcomes

1. Comprehend the different classifications of unconstrained and constrained optimization problem formulations.
2. Understand and apply the different types of unconstrained optimization techniques that are available using high-level software tools.
3. Implement in computer code some of the different techniques to get a better understanding of how they work.
4. Formulate engineering design problems as an optimization problem and apply the techniques that have been learned.

Important Dates

- **Voluntary Withdrawal Deadline**
March 20th, 2024
- **Louis Riel Day**
February 19th, 2024
No classes or examinations
- **Spring Break**
February 20th – 23rd, 2024
No classes or examinations
- **Good Friday**
March 29th, 2024
No classes or examinations

Accreditation Details

Accreditation Units

- Mathematics: 20%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 50%
- Engineering Design: 30%

Graduate Attributes

KB: A knowledge base for engineering
 PA: Problem analysis
 IN: Investigation
 DE: Design
 ET: Use of engineering tools
 IT: Individual and team work
 CS: Communication skills
 PR: Professionalism
 IE: Impact of engineering on society/
 environment
 EE: Ethics and equity
 EP: Economics and project
 management
 LL: Life-long learning

Competency Levels

I - Introduced (Introductory)
 D - Developed (Intermediate)
 A - Applied (Advanced)

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	D											
2	A	A			A		A	A				
3	A	A	A	A	A		A	A				
4		A	A	A	A		A	A				

CEAB Graduate Attributes Assessed

PA.4 – Evaluates a solution to a complex engineering problem.

CS.1 – Designs and produces effective written and graphical engineering documents for specific audiences. (ex. research reports, engineering reports, design documents.)

Evaluation

The final course grade is determined by the student's performance in laboratories, and on the project. Students must complete all the laboratories, assignments and the project in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Laboratory Assignments	60	F, S	
Final Project	40	S	

* Method of Feedback: F - Formative (written comments and/or oral discussion), S - summative (numerical grade)

Student Absences

Attendance in lectures, tutorials, and laboratories is mandatory. For short-term absences due to illness or other extenuating circumstances of 120 hours (5 days) or less, students are required to complete a *Self-Declaration Form for Brief or Temporary Absence* available on the University website. This form must be submitted to the course instructor within 48 hours of the absence. (No additional documentation is required.)

Note that students are responsible to complete any missed work and must consult with the instructor to make appropriate arrangements.

For absences longer than 120 hours, students must contact the instructor and ECE Undergraduate Advisor, Tammy Holowachuk (Tammy.Holowachuk@umanitoba.ca) for further instructions.

Deferred Final Examinations

Students who miss the regular scheduled writing of a final examination, for valid medical or compassionate reasons, may be given the opportunity to write a deferred examination, subject to approval by the Associate Dean (Undergraduate). All requests for a deferred examination must be made within 48 hours of the missed examination, and must follow the procedure described on the Faculty website, without exception. Course instructors do not have the discretion to grant deferred final examinations.

(<https://umanitoba.ca/engineering/student-experience#engineering-student-policies>)

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations on Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

Copyright Notice

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Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a passing final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's General Academic Regulations, as well as Section 3 of the Faculty of Engineering Academic Regulations dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

 [Supplemental Resources](#)

Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.