Department of Mathematics & Statistics
Concordia University

MATH 479 (MAST 661/MAST 837) Sec. A

Convex and Non-Linear Analysis

Fall 2024

Instructor: Dr. A. Stancu, Office: LB 921-23 (SGW), Phone: (514) 848-2424, Ext. 3230
Email: alina.stancu@concordia.ca

Class Schedule: Tuesdays & Thursdays, 11:45-13:00.
Mid-term break: no class between October 15, 2024, and October 20, 2024.

Office Hours: Tuesdays, 10h00-11h30.

Note that, if a student misses a lecture, the professor will not use office hours to make up for the student's missed class. Office hours are to clarify and better assimilate the material of the course that the student tried first to understand from the lecture or textbook in an individual study.

References: The course will consist of a selection of topics listed on the next page for which you may consult the following sources (all e-books):

1. *Convex functions and their applications: a contemporary approach* by C. P. Niculescu and L.-E. Persson, Springer (2018) **E-link at Concordia's library.**

2. *Convex Optimization* by Boyd and Vanderberghe, Cambdridge University Press (2004), available on Dr. Boyd's web page at Stanford University (check also the book's errata on the same web page for possible typos).

3. *Lectures in Convex Geometry* by D. Hug and W. Weil, Springer (2020) **E-link at Concordia's library.**

4. *Convex and discrete geometry* by Peter M. Gruber, Springer (2007) **E-link at Concordia's library.**

Summary: Starting with classical properties of convex sets and functions, the course aims to present several classical inequalities like the Brunn-Minkowski inequality and its related functional form, Prekopa-Leindler, the Blaschke-Santaló inequality, the Urysohn inequality, as well as more recent results such as the reverse isoperimetric inequality, and the Brascamp-Lieb inequality and its reverse form. In the process, we will touch upon log-convex functions, duality for sets and functions and, generally, extremum problems. Finally, the course will cover some applications of convexity in the discrete setting, particularly to number theory.

A tentative schedule is listed below. The schedule is subject to change during the term to adjust to the mathematical interest and background of the audience.

Week	Topics
1 - 3	Convex sets; separation theorems; polar sets; ellipsoids, John's Theorem.
4 - 6	Convex functions; criteria of convexity for differentiable functions; inequalities for convex functions; conjugate functions; the Brunn-Minkowski theorems.
-	**Reading week**
7	**Problem Solving / Q&A and Midterm**
8 – 9	Polarity, duality and applications; symmetrizations and rearrangements of convex sets.
10 - 12	Convexity on lattices and applications to number theory

Grading: **Homework (20%), Midterm (40%), and Final evaluation (40%).**

The evaluations of undergraduate students will be different in content than the evaluations of graduate students.

The homework will be assigned approximately every two weeks during class and posted on Moodle. It is the student's responsibility to upload the assignment on Moodle on time. **No late assignments will be accepted. No submissions by email will be accepted either.**

If the grading scheme for this course includes graded assignments, a reasonable and representative subset of each assignment may be graded. Students will not be told in advance which subset of the assigned problems will be marked and should therefore attempt all assigned problems.

A midterm exam will be held in class on Thursday, October 24, 2024, covering the material taught during the first six weeks of classes.

The final examination will cover material from the entire course. All examinations are, for now, planned to be in person, but could be moved online if the university advises so.

Final Note: Active participation in class and continuous work on the course material throughout the term is important for success in this course. Read the course material and do the assignments on your own. By assuming a responsible behavior (see also the **Academic Integrity and the Academic Code of Conduct** below), you will also achieve a better understanding of the material.

Academic Integrity and the Academic Code of Conduct

This course is governed by Concordia University's policies on Academic Integrity and the Academic Code of Conduct as set forth in the Undergraduate Calendar and the Graduate Calendar. Students are expected to familiarize themselves with these policies and conduct themselves accordingly. "Concordia University has several resources available to students to better understand and uphold academic integrity. Concordia's website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: https://www.concordia.ca/conduct/academic-integrity.html" *[Undergraduate Calendar, Sec 17.10.2]*

Behaviour

All individuals participating in courses are expected to be professional and constructive throughout the course, including in their communications.

Concordia students are subject to the Code of Rights and Responsibilities which applies both when students are physically and virtually engaged in any University activity, including classes, seminars, meetings, etc. Students engaged in University activities must respect this Code when engaging with any members of the Concordia community, including faculty, staff, and students, whether such interactions are verbal or in writing, face to face or online/virtual. Failing to comply with the Code may result in charges and sanctions, as outlined in the Code.

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Extraordinary circumstances

In the event of extraordinary circumstances and pursuant to the Academic Regulations the University may modify the delivery, content, structure, forum, location and/or evaluation scheme. In the event of such extraordinary circumstances, students will be informed of the change.