Department of Mathematics & Statistics
Concordia University

MAST 661 (MATH 494/MAST 837), Sec. B
Selected Topics in Analysis
Topic: "Harmonic Analysis and applications"
Winter 2026

Instructor: Dr. G. Dafni
Email: galia.dafni@concordia.ca

Class Schedule: Wednesdays, 5:45-8:15 pm.
Mid-term break: No classes from March 2 to March 8, 2026.

Office Hours: (tentatively) Mondays, 4:30-6:00 pm including problem-solving sessions; and by appointment.

Textbooks: Recommended:
Fourier Analysis: An Introduction, by E. M. Stein & R. Shakarchi.
An Introduction to Harmonic Analysis, by Y. Katznelson.
Harmonic Analysis from Fourier to Wavelets, by C. Pereyra and L. Ward.

Other Texts: Other references (on reserve in Weber library, or available online):
Ten Lectures on Wavelets, by Ingrid Daubechies.
Fourier Series and Integrals, by H. Dym and H. P. McKean.
Fourier Analysis and its Applications, by G. B. Folland.
Real Analysis: Modern Techniques and Their Applications, by G. B. Folland.
Fourier Analysis, by T. W. Korner.
Wavelets and Operators, by Yves Meyer.
Real and Complex Analysis, by W. Rudin.
Functional Analysis, by W. Rudin.
Functional Analysis: Introduction to Further Topics in Analysis, by E. M. Stein & R. Shakarchi.
Introduction to Fourier Analysis on Euclidean Spaces, by E. M. Stein & G. Weiss.
Harmonic Analysis: Real-Variable Methods, Orthogonality, and Oscillatory Integrals, by E. M. Stein,
Singular integrals and differentiability properties of functions, by E. M. Stein.
Trigonometric Series, by A. Zygmund.

Topics:

1. Fourier series on the circle
   - Introduction: the origins of Fourier analysis (independent reading: Stein & Shakarchi 1)
   - Convergence of Fourier series (basic: Stein & Shakarchi 2-3, extra: Katznelson I-II)
   - The Hardy-Littlewood maximal function (extra: Katznelson III.2. Rudin R&C 7, Stein SI I)
   - Applications of Fourier series (Stein & Shakarchi 4)
   - Harmonic functions, Poisson integrals and the conjugate function (Katznelson III, Rudin 11, Stein & Weiss II)
2. Fourier transforms on the line and on R^n
   - Definition and properties of the Fourier transform, the Schwartz space (basic: Stein & Shakarchi 5-6, extra: Katznelson VI, Rudin R&C 9, Stein & Weiss I)
   - Tempered distributions (extra: Stein & Weiss I, Stein & Shakarchi FA 3, Rudin FA 6)
   - The Poisson Summation Formula (Stein & Shakarchi 5, Katznelson VI)
3. Wavelets
   - Haar wavelets (Pereyra & Ward, Ch. 9)
   - Multiresolution analysis (Pereyra & Ward, Ch. 10)
   - Calculating with wavelets (Pereyra & Ward, Ch. 11)
4. Additional topics if time permits:
   - Interpolation (Katznelson IV, Stein & Weiss V)
   - Singular integrals (Stein SI II, Stein & Weiss II, VI)
   - Littlewood-Paley Theory
   - Hardy spaces, BMO (Stein & Shakarchi FA 2, Katznelson III.3, Rudin 17, Stein HA III, IV)
   - Weak/weak* topologies; topological vector spaces, distributions (Rudin FA 1,6)
   - Applications to PDE, Sobolev spaces (Stein & Shakarchi 5-6, extra: Rudin FA 8)
   - Spherical harmonics (Stein & Weiss IV)
   - Fourier analysis on groups, the discrete Fourier transform (Stein & Shakarchi 7)
   - Applications to number theory (Stein & Shakarchi 8)

Prerequisites: Previously: real analysis/metric spaces (equivalent to MATH 464); Recommended: measure theory (equivalent to MATH 467/669); basic complex analysis (equivalent to MATH 366).

Assignments: Homework will be assigned approximately once every two weeks, on Moodle. **Solutions must be handwritten and submitted on paper during class. Late homework will not be accepted.**

Working together with other students in the class on the homework assignments is allowed and encouraged, and problem-solving sessions will provide an opportunity for this. However, the solutions you submit must be written by you, in your own words and your own writing style, and follow the University's Academic Code of Conduct.

Understanding of the homework is essential to success in the exams.

Midterm Exam: There will be an in-class closed-book midterm exam during the 6th or 7th week of classes. The exact date of the exam will be announced in class at least a week in advance.

Final Exam: The final examination will be a 3-hour-long closed-book exam, scheduled by the Examinations Office.

PLEASE NOTE: Students are responsible for finding out the date and time of the final exam once the schedule is posted by the Examination Office. Any conflicts or problems with the scheduling of the final exam must be reported directly to the Examination Office, **not** to your instructor. It is the Department's policy and the Examination Office's policy **that students are to be available until the end of the final exam period. Conflicts due to travel plans will not be accommodated.**

Evaluation: Homework assignments 35%, Midterm exam 25%, Final exam 40%. Following the results of the midterm exam, students can opt to do an oral presentation at the end of the course (on a topic to be agreed upon with the instructor) to change that portion of the grade to Midterm exam 15%, Oral Presentation 10%.

Graduate students will be required to do additional or alternative work, to be determined, according to their level (Master's/PhD).

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.

Communication: Communication between the students and the instructor will take place in person and online via lectures, Zoom meetings, Moodle announcements, and email messages. **Students are responsible for reading and taking notes of all electronic communication from the instructor and the University.**

Student Services
You may wish to access the many services available to you as a Concordia student. An overview of these resources can be found here: https://www.concordia.ca/students/services.html

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.

Intellectual Property
Content belonging to instructors shared in online courses, including, but not limited to, online lectures, course notes, and video recordings of classes remain the intellectual property of the faculty member. It may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member. Students are also forbidden to use their own means of recording any elements of an online class or lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the Academic Code of Conduct and/or the Code of Rights and Responsibilities. As specified in the Policy on Intellectual Property, the University does not claim any ownership of or interest in any student IP. All university members retain copyright over their work.

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.