

Course Syllabus

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Section 101: MWF 1:00-1:50. Credit value: 3 credits.

Instructor: Professor I. Laba

- **Bio:** Ph.D. 1994 (University of Toronto). At UBC since 2000. Full Professor since 2005.
- **Email:** ilaba@math.ubc.ca
- **Office hours:** by appointment. Normally, I will also be available to answer questions after each class.
- **Contact information:** For **general questions** about course material and homework, please use Piazza or Discussions on Canvas. For **individual and confidential matters** such as academic concession, please use Inbox -> Conversations on Canvas. Inquiries submitted on evenings and weekends will be answered on the next business day.

Prerequisites: MATH 300 and a score of 68% or higher in MATH 321, or equivalent background in real analysis.

Co-requisites: MATH 420/507.

Course objectives: Harmonic analysis is an active and exciting area of research, with deep connections to many other areas of mathematics such as geometric measure theory, combinatorics, and number theory. This course will offer an introduction to some of today's hottest research questions and give you the tools to navigate the literature on the subject:

- Learn the basic concepts of harmonic analysis on Euclidean spaces.
- Apply harmonic-analytic methods to questions in number theory, PDE and geometric measure theory.
- Practice formal mathematical proofs and high quality mathematical writing.

Course topics:

- Fourier series, their summability and convergence
 - Application: Weyl's equidistribution theorem.
- The Fourier transform on $\mathbf{R}^n$
 - The Schwartz space
 - Convolution and approximate identities
 - Fourier inversion and Plancherel's theorem
 - L^p spaces and the Hausdorff-Young formula
 - The uncertainty principle

- The Poisson summation formula
- Real-variable theory and applications of Fourier analysis
 - Lebesgue density theorem
 - The Hardy-Littlewood maximal function
 - Spherical maximal operators, with applications to PDE theory
 - Kakeya sets and Kakeya-type maximal operators (if time allows)

A more detailed tentative schedule of class topics and textbook sections covered each week [is posted here \(https://canvas.ubc.ca/courses/192353/pages/course-topics-and-schedule\)](https://canvas.ubc.ca/courses/192353/pages/course-topics-and-schedule). We may adjust the schedule and choice of optional topics depending on the background and interests of the participants.

Recommended textbooks:

- *Fourier Analysis*, J. Duoandikoetxea, American Mathematical Society, 2001
- *An Introduction to Harmonic Analysis*, Y. Katznelson, Cambridge University Press, 2004
- *Fourier Analysis: An Introduction*, E.M. Stein and R. Shakarchi, Princeton University Press, 2003
- *Real Analysis: Measure Theory, Integration, and Hilbert Spaces*, E.M. Stein and R. Shakarchi, Princeton Univ. Press, 2005
- *Lectures on Harmonic Analysis*, T. Wolff, American Mathematical Society, 2003. ([Full text available online \(http://www.math.ubc.ca/~ilaba/wolff/notes_march2002.pdf\)](http://www.math.ubc.ca/~ilaba/wolff/notes_march2002.pdf), with the publisher's permission.)

Course structure and learning activities:

- **Lectures, MWF 1-1:50:** Introduction to the material, with opportunities for questions and discussion.

Textbooks: The recommended textbooks are listed above. Specific reading recommendations for each topic will be provided. Additionally, I will post lecture notes where available.

Discussion boards: Both Piazza and Discussions on Canvas will be available.

Your course mark will be based on:

- 4-5 homework assignments, for a total of 70%. Each one will be posted at least one week in advance, and the questions may include working out the details of arguments from class. The assignments will be weighed equally, except that your lowest score will be dropped to allow for minor illnesses and other emergencies. Your solutions should be written clearly and carefully. You are welcome to work on the assignments with other students, but the final write-up should be your own.
- 4-5 short in-class quizzes for a total of 20%, also with the lowest score dropped. The quizzes will be about 15-20 minutes long and will only include basic (for this course) material, for example short applications of results from class. Each quiz will be announced at least 1 week in advance.

- An individual in-person "office hour", for a total of 10% given on a pass/fail basis. Starting in late September, I will be asking each of you to make a short appointment (20-30 minutes) to discuss class material. I may ask you questions about your assignments or other course topics, but this is also your opportunity to bring questions and provide feedback. The default mark is "pass" as long as the appointment is completed and there are no major concerns; in the unlikely event you do not pass the first time, you will have an opportunity to retry with no loss of credit.
- There will be no final exam.

Academic concession: The rules and procedures for obtaining academic concession are governed by [UBC Policy V-135 on Academic Concession](http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0) (<http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0>). The details in this course are as follows.

- **Late or missed homework:** Late assignments will not be accepted, in order to discourage pile-ups of overdue work and allow the timely posting of solution sets for everyone. (If you cannot complete an assignment before the deadline for a valid reason, see below.)
- **To account for minor illnesses and emergencies,** the grading policy allows for one homework assignment and one quiz to be missed with no penalty. Any academic concession requests involving two or more missed assignments or quizzes should be discussed with me as soon as possible.
- Please note that academic concession for certain reasons, such as valid schedule conflicts that can be foreseen, must be requested in advance and may require additional documentation.

Academic integrity: UBC takes cheating incidents very seriously. After due investigation, students found guilty of cheating on tests and examinations are usually given a final grade of 0 in the course and suspended from UBC for one year.

- While students are encouraged to study together, you should be aware that blatant copying of another student's work is a serious breach of academic integrity. Your final write-up should be your own and you are responsible for the work you submit.
- Academic misconduct includes misrepresenting a medical excuse or other personal situation for the purposes of postponing an examination or quiz or otherwise obtaining an academic concession.

Please see the [Academic Calendar statement on Academic Misconduct](https://vancouver.calendar.ubc.ca/campus-wide-policies-and-regulations/student-conduct-and-discipline/discipline-academic-misconduct) (<https://vancouver.calendar.ubc.ca/campus-wide-policies-and-regulations/student-conduct-and-discipline/discipline-academic-misconduct>) for more information.

Generative AI use is not permitted in any work submitted for credit in this class. While the use of AI tools may become more common among mathematicians in the future, you should be aware that such tools do not necessarily generate either correct mathematical content or professionally acceptable writing. The focus of this class is on developing and exercising your own cognitive skills, including those needed to evaluate AI outputs and make your own judgements.

Additional resources for proof writing:

- **[Francis Su's handouts on mathematical writing](https://math.hmc.edu/su/writing-math-well/)** (<https://math.hmc.edu/su/writing-math-well/>) include good examples and recommendations. Please don't treat these as strict rules that you have to follow 100% of the time. (Some level of informality is OK in homework assignments, for example you don't have to end every calculation with a punctuation sign. My posted lecture notes are a little bit informal. But this should give you a good idea of how you can make your mathematical writing clear and easy to understand.)

Weather Contingency Plan for Class Sessions: Please check ubc.ca (<http://ubc.ca/>) often during bad weather or snow. If a class session is cancelled, the default contingency plan will be to have an online class on Zoom. For those who cannot attend an online class at short notice, a recording will be posted on Canvas. Please check Canvas for more information.

Statement about the University's values and policies, mandated by [UBC Policy V-130](http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,328,0,0) (<http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,328,0,0>): UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available [here](http://senate.ubc.ca/policies-resources-support-student-success) (<http://senate.ubc.ca/policies-resources-support-student-success>).