CS 860 – Algorithmic Spectral Graph Theory

Spring 2026 course outline

Last updated: 22 June 2026
Course website: https://cs.uwaterloo.ca/~lapchi/cs860-2026

Please note that any term-specific content of this document is decided tentatively at the beginning of the term, and is subject to change. See the course website for current, up-to-date information.

Instructor

Name:	Lap Chi Lau
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Office:	DC 1309
Office hours:	Tuesdays 12:30-1:30.

Lectures

Tuesdays and Thursdays, 10:00-11:20, DC 2568.

Course Description

This course begins with a review of classical results in spectral graph theory, followed by an exploration of several recent major developments, with a focus on algorithmic results.

Course Text

Course notes will be provided. There is no required textbook in this course. The following is a list of main references.

- Spectral Graph Theory, by Dan Spielman.
- Mordern Spectral Graph Theory, by Shayan Oveis Gharan.
- Graph Partitioning, Expanders and Spectral Methods, by Luca Trevisan.

Posting Lecture Slides and Course Information

The lectures notes, syllabus, and assignments will be posted in the course homepage at https://cs.uwaterloo.ca/~lapchi/cs860-2026.

Announcements and discussions about the course material or assignments will take place on Slack.

Course requirements

Taken a first course in algorithms, a first course in linear algebra, and a first course in probability.

Evaluation

Class participation	20%
Assignments	30%
Project	50%

Assignment policy

Students are allowed to collaborate with other students about the assignments. If you collaborate with others, you must clearly indicate the collaboration *for each problem*. In any case, you must write your own solutions, without the help of others and without the use of any references other than the course notes and the three main references.

Use of Generative Artificial Intelligence:

The following statement is prepared by the Office of Academic Integrity with input from the Centre for Teaching Excellence, Library, and consultations with Associate Deans and members of the Standing Committee on New Technologies, Pedagogy, and Academic Integrity (Last Updated: August 2023):

Generative artificial intelligence (GenAI) trained using large language models (LLM) or other methods to produce text, images, music, or code, like Chat GPT, DALL-E, or GitHub CoPilot, may be used for assignments in this class with proper documentation, citation, and acknowledgement. Recommendations for how to cite GenAI in student work at the University of Waterloo may be found through the Library.

Please be aware that generative AI is known to falsify references to other work and may fabricate facts and inaccurately express ideas. GenAI generates content based on the input of other human authors and may therefore contain inaccuracies or reflect biases. In addition, you should be aware that the legal/copyright status of generative AI inputs and outputs is unclear. Exercise caution when using large portions of content from AI sources, especially images. More information is available from the Copyright Advisory Committee.

You are accountable for the content and accuracy of all work you submit in this class, including any supported by generative AI.

Regrading Request

Requests for regrading will be accepted up to 14 days after students can pick up their assignments. Details of how to request a regrade will be posted in Piazza after the first assignment is due.

Topics to be Covered (Tentative)

- Classical Results: Cheeger's inequality, random walks, expander graphs
- Topic 6: Matrix Concentration, spectral sparsification, CSP refutation, Kikuchi matrices.
- Topic 4: Cut-matching game, matrix multiplicative update, Sherman's algorithm

- Topic 5: Threshold rank decomposition, semidefinite programming, global correlation rounding, reweighing conjecture
- Topic 7: High-dimensional expanders and mixing time

Academic Integrity
In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. All members of the UW community are expected to hold to the highest standard of academic integrity in their studies, teaching, and research. The Office of Academic Integrity's website (https://www.uwaterloo.ca/academicintegrity) contains detailed information on UW policy for students and faculty. This site explains why academic integrity is important and how students can avoid academic misconduct. It also identifies resources available on campus for students and faculty to help achieve academic integrity in — and out — of the classroom.

Grievance
A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, https://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm

Discipline
A student is expected to know what constitutes academic integrity, to avoid committing academic offences, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about 'rules' for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offences and types of penalties, students should refer to Policy 71 - Student Discipline, https://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm

Avoiding Academic Offences:
Most students are unaware of the line between acceptable and unacceptable academic behaviour, especially when discussing assignments with classmates and using the work of other students. For information on commonly misunderstood academic offences and how to avoid them, students should refer to the Faculty of Mathematics Cheating and Student Academic Discipline Policy, https://www.math.uwaterloo.ca/navigation/Current/cheating_policy.shtml

Appeals:
A student may appeal the finding or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals, https://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm

Note for students with disabilities:
The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.
See http://www.studentservices.uwaterloo.ca/disabilities for more information.

Turnitin.com
Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.

Continuity Plan
If in-person classes are canceled, whether for the particular course or University-wide, we will have online Zoom lectures at the same time (Monday and Wednesday 10:00-11:20). If in-person exams are canceled (in response to decisions affecting the entire University), we will have remote exams at the same scheduled time via CrowdMark. Students who cannot attend in-person classes due to self-isolation will still be able to read lecture notes. If students cannot take the final due to COVID-19, it will be handled similarly to other illness-related issues.

Mental Health Support
The Faculty of Math encourages students to seek out mental health support if needed.

On-campus Resources:

- Campus Wellness https://uwaterloo.ca/campus-wellness/
- Counselling Services: counselling.services@uwaterloo.ca 519-888-4567 ext. 32655
- MATES: one-to-one peer support program offered by Waterloo Undergraduate Student Association (WUSA) and Counselling Services: mates@wusa.ca
- Health Services: located across the creek from the Student Life Centre, 519-888-4096.

Off-campus Resources:

- Good2Talk (24/7): Free confidential help line for post-secondary students. Phone: 1-866-925-5454 (Ontario and Nova Scotia only)
- Here 24/7: Mental Health and Crisis Service Team. Phone: 1-844-437-3247 (Waterloo Region only)
- OK2BME: set of support services for lesbian, gay, bisexual, transgender, or questioning teens. Phone: 519-884-0000 extension 213 (Waterloo Region only)
- EMPOWER ME 1-833-628-5589 for Cdn./USA other countries see: http://studentcare.ca/rte/en/IHaveAPlan_WUSA_EmpowerMe_EmpowerMe
- EMPOWER ME in China:
  China North 108007142831
  China South 108001402851

Diversity

It is our intent that students from all diverse backgrounds and perspectives be well served by this course, and that students' learning needs be addressed both in and out of class. We recognize the immense value of the diversity in identities, perspectives, and contributions that students bring, and the benefit it has on our educational environment. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups. In particular:

- We will gladly honour your request to address you by an alternate/preferred name or gender pronoun. Please advise us of this preference early in the term so we may make appropriate changes to our records.
- We will honour your religious holidays and celebrations. Please inform of us these at the start of the course.
- We will follow AccessAbility Services guidelines and protocols on how to best support students with different learning needs.