St. Francis Xavier University
Department of Computer Science

CSCI 435: Algorithms and Complexity
Course Outline
Winter 2023

1 Course Overview

This course provides an introduction to some fundamental areas of research in algorithms and computational complexity theory. Flow networks and randomized, approximation, parameterized, and online algorithms and complementary techniques in hardness of approximation and lower bounds are presented. This course is a broad exploration of these topics to provide a well-rounded introduction to modern theories in algorithms and theoretical computer science.

Prerequisites. CSCI 355 (Algorithm Design and Analysis) or permission of the chair.

2 Learning Objectives

By the end of this course, you will be able to:

- Understand the mapping of real-world problems to algorithmic solutions (e.g., as graph problems, linear programs, etc.).
- Select and apply advanced algorithmic techniques (e.g., randomization, approximation) to solve real problems.
- Select and apply advanced analysis techniques (e.g., amortized, probabilistic, etc.) to algorithms.
- Determine an appropriate algorithmic approach to a problem.

Objectives from *CS2013: Curriculum Guidelines for Undergraduate Programs in Computer Science*, ACM/IEEE.

3 Instructor

Taylor J. Smith

- Email: `tjsmith@stfx.ca`
- Office location: Annex, Room 9A
- Student hours: Tuesday, 9:15am–11:15am

4 Class Time and Location

- Tuesday, 8:15am–9:05am
- Wednesday, 10:15am–11:05am
- Friday, 9:15am–10:05am

All lectures are held in Mulroney Hall, Room 3024.

5 Evaluations

Your final grade will be based on the following components:

- Three assignments (15% each, total 45%)
- Research article discussions (10%)
- Midterm examination (25%)
- Final examination (20%)

You must write the final examination in order to pass the course, even if the weighted sum of your other submissions is at least 50%.

Your mid-term grade will be communicated to you by the deadline specified in the university's Academic Regulations. Your mid-term grade will consist of the weighted sum of the grades of your first assignment and your midterm examination.

6 Method of Instruction

This course will be delivered face-to-face (i.e., all contact between instructor and students is in a physical classroom on campus). Course materials will be posted to the instructor's website.

7 Tentative Course Schedule

Week/Date	Topic	Due Dates
Week 1	Introduction to course, review of CSCI 355	
Week 2	Online algorithms	
Week 3	Online algorithms (cont'd)	
Week 4	Randomized algorithms	**Assn. 1** (Jan. 24)
Week 5	Randomized algorithms (cont'd)	
Week 6	NP-completeness and complexity theory	
Week 7	Mid-course review, **midterm examination**	
Week 8	Amortized analysis	**Assn. 2** (Feb. 28)
Week 9	Approximation algorithms	
Week 10	Approximation algorithms (cont'd)	
Week 11	Fixed-parameter algorithms	**Assn. 3** (Mar. 28)
Week 12	Fixed-parameter algorithms (cont'd), course review	

8 Course Materials and Resources

Course notes will be provided for each lecture. The course textbooks will be used as optional supplements.

Required Text. None.

Recommended Texts.

General material: J. Kleinberg and É. Tardos, *Algorithm Design*. Pearson Addison-Wesley, 2005.

Online algorithms: A. Borodin and R. El-Yaniv, *Online Computation and Competitive Analysis*. Cambridge University Press, 1998.

Randomized algorithms: R. Motwani and P. Raghavan, *Randomized Algorithms*. Cambridge University Press, 1995.

Approximation algorithms: D. P. Williamson and D. B. Shmoys, *The Design of Approximation Algorithms*. Cambridge University Press, 2011.

Fixed-parameter algorithms: R. G. Downey and M. R. Fellows, *Fundamentals of Parameterized Complexity*. Springer, 2013.

9 Method of Evaluation

Assignments. This component will give you an opportunity to both demonstrate your understanding of course material and apply your understanding to a variety of problems. Each of the three assignments will consist of questions relating to material covered in the course between the assignment being issued and the due date. Assignments must be completed individually.

Research Article Discussions. As the course overview states, this course is an introduction to "some fundamental areas of research in algorithms". Thus, part of this course will entail reading both historical and contemporary research articles pertaining to the material we learn in lectures. This component will enable you to understand, analyze, and evaluate the ideas presented in a variety of research articles through a set of discussion questions to be completed prior to lectures and discussed/submitted in lectures.

Midterm and Final Examinations. These components will serve as a diagnostic to gauge your individual understanding of course material. Each examination will consist of questions relating to material covered in the course up to the date of that exam. You will have 50 minutes (i.e., the duration of one lecture) to complete the midterm examination. The final examination will be scheduled by the university.

Supplemental Statements
for Course Outline

A Prerequisite Checking

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Refer to the current StFX Academic Calendar at `https://www2.mystfx.ca/registrars-office/academic-calendars`.

B Statement on Preferred Pronouns

Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

See policies at `http://www2.mystfx.ca/equity/policies`.

C Statement on Electronic Devices

During Exams: Unless you have medical accommodations that require you to do so, or explicit permission from the instructor of the course, you may not use any of the following electronic devices during ANY of the tests, midterms, examinations, or other in-class evaluations: cellphones, smart phones, smart watches, smart glasses, audio players or recorders of any sort, video cameras, video games, DVD players, televisions, laptop/notebook/netbook computers, flashlights or laser pointers.

During Lectures and Tutorials: Course instructors may permit the use of a computer during lecture and tutorial periods. If so, you are expected to use the computer for scholastic purposes only, and refrain from engaging in any activities that may distract other students from learning. From time to time, your professor may ask the class to turn off all computers, to facilitate learning or discussion of the material presented in a particular class. *Unless explicitly noted otherwise, you may not make audio or video recordings of lectures – nor may you edit, re-use, distribute, or re-broadcast any of the material posted to the course website.*

D Copyright

The materials in CSCI 435: Algorithms and Complexity at StFX are the property of the instructor, unless stated otherwise by the instructor. Online posting or selling this material to third parties for distribution without permission is subject to Canadian Copyright law and is strictly prohibited.

Please visit the StFX copyright guide for more information: `http://sites.stfx.ca/library/campus_copyright`.

E Policy on Academic Integrity

Please ensure that you are aware of the policy on Academic Integrity. Details can be found at: `http://www.sites.stfx.ca/registrars_office/academic_integrity`. Please make note of the change in wording of the section on 'Cheating' passed by Senate this year. Section 3.8.2b (v) now reads "Possession of unauthorized aids or assistance". This means that the students do not need to be caught USING a device like a cell phone or smart watch (for example) during a test or exam to be in violation of the policy. Simply having the unauthorized device on your person during the test or exam is a violation of the policy.

F Statement on Equitable Learning

Everyone learns more effectively in a respectful, safe and equitable learning environment, free from discrimination and harassment. Instructors and students are invited to work together to create a classroom space – both real and virtual – that fosters and promotes values of human dignity, equity, non-discrimination, and respect for diversity. Please feel free to talk with your course instructor about your questions or concerns about equity in our classroom or in the StFX community in general.

Should students have additional questions, they are encouraged to talk to the Chair/Coordinator of the Department/Program or the Human Rights and Equity Advisor. Contact information can be found at `https://www2.mystfx.ca/equity/staff`.

G Information about Requesting an Accommodation at StFX

If you have a different learning ability and would like to request accommodations, please contact the instructor during the first week of the semester so that your accommodations may be provided in a timely manner. Centre for Accessible Learning (CAL) provides assistance in determining and facilitating appropriate accommodations for students with verified disabilities.

The Tramble Center for Accessible Learning welcomes students with documented permanent disabilities and offers them a student-centered program of support. Located in Room 108 of the Angus L. MacDonald Library, new and returning students meet with program staff to discuss options for support. Deadline for registering with the Center is two weeks prior to the end of classes each semester and three business days notice is required for booking all accommodated tests and exams.

To book an appointment, please use the following link: `stfxcal.mywconline.com`.

Phone: (902) 867-5349
Email: `tramble@stfx.ca`

H Support Services

There are various support services around campus and these include, but are not limited to:

1. Student Life: `https://www.stfx.ca/student-life`
2. Office of the Registrar: `https://www2.mystfx.ca/registrars-office/`
3. Health & Counselling Centre: `https://www.stfx.ca/student-life/health-and-wellness`
4. Academic Advising: `https://www2.mystfx.ca/academic-advising/`
5. Student Success Centre: `https://www2.mystfx.ca/student-success/`
6. Student Career Centre: `https://www2.mystfx.ca/scc/`
7. Office of Internationalization: `https://www.stfx.ca/international/support-international-students`
8. Financial Aid Office: `https://www2.mystfx.ca/financial-aid/`

I Health and Wellness

As part of a successful undergraduate experience at St. Francis Xavier University, we encourage you to make your health and wellness a priority. StFX provides several on-campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your degree. For example, to support physical activity, all students receive membership to the StFX Athletics & Recreation Centre as part of their registration fees. Please visit the Athletics & Recreation website (`https://www.stfx.ca/student-life/athletics-and-recreation`) for opportunities including intramural sports. Numerous cultural events are offered throughout the year. Please check out the Department of Music web page (`https://www2.mystfx.ca/music/visiting-artist-program`), the StFX Art Gallery (`https://www2.mystfx.ca/art-gallery/`) or Theatre Antigonish (`https://www.theatrens.ca/producers?c=theatre-antigonish`) for various events.

Further information regarding health and wellness-related services available to students may be found at `https://www.stfx.ca/student-life/health-and-wellness`. If you are in emotional or mental distress please refer to the various mental health supports provided through Health & Counselling at `https://www2.mystfx.ca/health-and-counselling/`.