

St. Francis Xavier University
Department of Computer Science
CSCI 356: Theory of Computing
Course Outline
Fall 2023

1 Course Overview

An introduction to the theoretical foundations of computer science, examining finite automata, context-free grammars, Turing machines, decidability and undecidability, and complexity theory. Strategies will be developed to help categorize problems as tractable or intractable.

Prerequisites. CSCI 255 (Advanced Data Structures), CSCI 277 (Discrete Structures).

2 Learning Objectives

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

- Discuss the concept of finite state machines.
- Design a deterministic finite state machine to accept a specified language.
- Generate a regular expression to represent a specified language.
- Explain why the halting problem has no algorithmic solution.
- Design a context-free grammar to represent a specified language.
- Define the classes P and NP.
- Explain the significance of NP-completeness.

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
- Office hours: Monday/Wednesday/Friday, 9:30am–10:30am

4 Class Time and Location

- Monday, 1:30pm–2:20pm
- Wednesday, 12:30pm–1:20pm
- Friday, 11:30am–12:20pm

All lectures are held in J. Bruce Brown Hall, Room 236.

Special Note for Fall 2023. On Tuesday, December 5, the Monday schedule of classes and labs will be offered again. On Wednesday, December 6, the Friday schedule of classes and labs will be offered.

5 Evaluations

Your final grade will be based on the following components:

- Four assignments (12.5% each, total 50%)
- Midterm examination (25%)
- Final examination (25%)

Assignments are due at the beginning of class on the due date. Late assignments will be accepted up to the beginning of the first class following the due date. Late assignments are subject to a penalty of 10% deducted from the earned mark.

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 two assignments and your midterm examination.

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

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, mathematical preliminaries	
Week 2	Regular languages: finite automata, nondeterminism	
Week 3	Regular languages: regular expressions, proving nonregularity	Assn. 1 (Sep. 20)
Week 4	Context-free languages: pushdown automata, grammars	
Week 5	Context-free languages: ambiguous grammars, proving non-CFness	
Week 6	Beyond context-free: Turing machines, variants of the model	Assn. 2 (Oct. 11)
Week 7	Mid-course review, midterm examination	
Week 8	Decidability, examples of decidable problems	
Week 9	Undecidability, proving a problem is undecidable	
Week 10	Time complexity: algorithm analysis, P, NP	Assn. 3 (Nov. 15)
Week 11	Time complexity: NP-completeness, reducibility	
Week 12	Space complexity: PSPACE, L, NL; course review	Assn. 4 (Dec. 6)

8 Course Materials and Resources

Course notes will be provided for each lecture. The course textbook will be used as an optional supplement.

Required Text. None.

Recommended Text. M. Sipser, *Introduction to the Theory of Computation*. Cengage, 3rd edition, 2012.

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 four 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.

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 enrol 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://www.stfx.ca/applications-admissions/registrar-office/academic-calendar>.

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 honour 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 <https://www.stfx.ca/human-rights-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

All materials in this course are designed for use in CSCI 356: Theory of Computing at StFX University and are the property of the instructor, unless otherwise stated by the instructor. Copying this material for distribution, online posting, or selling of this material to third parties without permission is subject to Canadian Copyright Law and is strictly prohibited.

E Policy on Academic Integrity

Please ensure that you are aware of the policy on Academic Integrity. Details can be found at <https://www.stfx.ca/applications-admissions/registrars-office/academic-integrity>.

You are responsible for understanding and adhering to all academic regulations that are outlined in Chapter 3 of the Academic Calendar. Refer to the current StFX Academic Calendar at <https://www.stfx.ca/applications-admissions/registrars-office/academic-calendar>.

Artificial intelligence aids are not permitted for use on any given assignment, essay, assessment, examination, etc. which is graded for evaluative purposes.

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://www.stfx.ca/human-rights-equity>.

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: <https://tramblecentre.stfx.ca/user/appt/default.aspx>.

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-support/student-services>
2. Office of the Registrar: <https://www.stfx.ca/applications-admissions/registrars-office>
3. Health & Counselling Centre: <https://www.stfx.ca/student-life-support/health-counselling-centre>
4. Academic Advising: <https://www.stfx.ca/student-life-support/academic-advising>
5. Student Success Centre: <https://www.stfx.ca/student-life-support/student-services/academic-success-centre>

6. Student Career Centre: <https://www.stfx.ca/student-life-support/student-services/student-career-centre>
7. Office of Internationalization: <https://www.stfx.ca/student-life-support/internationalization>
8. Financial Aid Office: <https://www.stfx.ca/applications-admissions/financial-support/financial-aid-office>

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-support/campus-life/campus-recreation>) for opportunities including intramural sports. Numerous cultural events are offered throughout the year. Please check out the Department of Music web page (<https://www.stfx.ca/department/music/visiting-artist-program>), the StFX Art Gallery (<https://www.stfx.ca/art-gallery>) or Theatre Antigonish (<https://www.festivalantigonish.ca/theatreantigonish/>) for various events.

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