

DEPARTMENT of Science

COURSE OUTLINE – Fall 2024

CS4040 A2, S1: Theory of Computation – 3 (3-2-0) 75 Hours for 15 Weeks

Northwestern Polytechnic acknowledges that our campuses are located on Treaty 8 territory, the ancestral and present-day home to many diverse First Nations, Metis, and Inuit people. We are grateful to work, live and learn on the traditional territory of Duncan's First Nation, Horse Lake First Nation and Sturgeon Lake Cree Nation, who are the original caretakers of this land.

We acknowledge the history of this land and we are thankful for the opportunity to walk together in friendship, where we will encourage and promote positive change for present and future generations.

INSTRUCTOR: Brian Redmond

OFFICE: J206

OFFICE HOURS: WF 10:00 AM – 11:30 AM
(or by appointment)

PHONE: 780-539-2982

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CALENDAR DESCRIPTION:

An introduction into advanced topics in the theory of computation. Topics include: basics of formal languages, models of computers, regular expressions, deterministic and nondeterministic finite automata, computability and computational complexity.

PREREQUISITE:

CS2720 – Formal Systems and Logic in Computing Science (3)

REQUIRED TEXT/RESOURCE MATERIALS:

Sipser, Michael. Introduction to the Theory of Computation. 3rd ed. Cengage Learning, 2012. ISBN: 9781133187790.

DELIVERY MODE(S):

Lectures Mondays and Wednesdays 8:30 AM – 10:00 AM in G111

Seminars Tuesdays 2:30 PM – 4:30 PM in G111

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

1. Understand formal languages and differentiate between regular, context-free, and non-context-free languages.
2. Construct and evaluate deterministic and nondeterministic finite automata and apply finite automata to recognize regular languages.
3. Design and use regular expressions to describe and manipulate regular languages and convert between regular expressions and finite automata.
4. Develop context-free grammars and analyze pushdown automata and their relationship with context-free languages.
5. Construct Turing machines for specific computational problems and explain the significance of Turing machines in defining the limits of computation.
6. Identify problems that are decidable and those that are undecidable and understand the Church-Turing thesis and its implications for computability.
7. Classify computational problems into complexity classes such as P and NP and explain the concept of NP-completeness.
8. Use the concept of reducibility to compare the difficulty of computational problems and analyze how reducibility affects the decidability and complexity of problems.
9. Critically evaluate the theoretical foundations of computation and formulate and defend arguments regarding the implications of computational theory in practical applications.

TRANSFERABILITY:

Please consult the Alberta Transfer Guide for more information. You may check to ensure the transferability of this course at the Alberta Transfer Guide main page <http://www.transferalberta.alberta.ca>.

** Grade of D or D+ may not be acceptable for transfer to other post-secondary institutions. **Students are cautioned that it is their responsibility to contact the receiving institutions to ensure transferability.**

EVALUATIONS:

Worksheets	30%
Midterm	20%
Final	50%

GRADING CRITERIA:

Please note that most universities will not accept your course for transfer credit IF your grade is less than C-.

Alpha Grade	4-point Equivalent	Percentage Guidelines	Alpha Grade	4-point Equivalent	Percentage Guidelines
A+	4.0	95-100	C+	2.3	67-69
A	4.0	85-94	C	2.0	63-66
A-	3.7	80-84	C-	1.7	60-62
B+	3.3	77-79	D+	1.3	55-59
B	3.0	73-76	D	1.0	50-54
B-	2.7	70-72	F	0.0	00-49

COURSE SCHEDULE/TENTATIVE TIMELINE:

Lecture/Seminar	Date	Topic	Reading
	Mon. Sept. 2	Labour Day – no classes	
	Tues. Sept. 3	No seminar this week	
L1	Wed. Sept. 4	Introduction	0.1, 0.2
L2	Mon. Sept. 9	Introduction	0.3, 0.4
S1	Tues. Sept. 10	Worksheet 1	
L3	Wed. Sept. 11	Finite Automata	1.1
L4	Mon. Sept. 16	Nondeterminism	1.2
S2	Tues. Sept. 17	Worksheet 2	
L5	Wed. Sept. 18	Regular Expressions	1.3
L6	Mon. Sept. 23	Nonregular Languages	1.4
S3	Tues. Sept. 24	Worksheet 3	
L7	Wed. Sept. 25	Context-Free Grammars	2.1
	Mon. Sept. 30	National Day for Truth and Reconciliation – no classes	

S4	Tues. Oct. 1	Worksheet 4	
L8	Wed. Oct. 2	Pushdown Automata	2.2
L9	Mon. Oct. 7	Non-Context-Free Languages	2.3
S5	Tues. Oct. 8	Worksheet 5	
L10	Wed. Oct. 9	Turing Machines	3.1
	Mon. Oct. 14	Thanksgiving – no classes	
S6	Tues. Oct. 15	Worksheet 6	
L11	Wed. Oct. 16	TM Variants	3.2
L12	Mon. Oct. 21	The Definition of Algorithm	3.3
S7	Tues. Oct. 22	Worksheet 7	
L13	Wed. Oct. 23	Decidable Languages	4.1
L14	Mon. Oct. 28	Undecidability	4.2
S8	Tues. Oct. 29	Worksheet 8	
L15	Wed. Oct. 30	Undecidable Problems from Language Theory	5.1
L16	Mon. Nov. 4	A Simple Undecidable Problem	5.2
S9	Tues. Nov. 5	Midterm	
L17	Wed. Nov. 6	Mapping Reducibility	5.3
	Mon. Nov 11	Remembrance Day – no classes	
	Tues. Nov. 12	Fall Break – no classes	
	Wed. Nov. 13	Fall Break – no classes	
L18	Mon. Nov. 18	Measuring Complexity	7.1
S10	Tues. Nov. 19	Worksheet 9	
L19	Wed. Nov. 20	The Class P	7.2
L20	Mon. Nov. 25	The Class NP	7.3
S11	Tues. Nov. 26	Worksheet 10	
L21	Wed. Nov. 27	NP-Completeness	7.4

	(Last Day to Withdraw)		
L22	Mon. Dec. 2	Additional NP-Complete Problems	7.5
S12	Tues. Dec. 3	Worksheet 11	
L23	Wed. Dec. 4	Relativization	9.2, 6.3
L24	Mon. Dec. 9	Review	
S13	Tues. Dec. 10	Worksheet 12	

Final exam period: Thursday, December 12 – Thursday, December 19, inclusive.

STUDENT RESPONSIBILITIES:

This is a challenging course. Success requires regular attendance, timely completion of assignments, and at least 10 hours of weekly study outside of class. Collaboration with classmates is encouraged, but each student must submit their own work and ensure they understand it fully.

STATEMENT ON ACADEMIC MISCONDUCT:

Academic Misconduct will not be tolerated. For a more precise definition of academic misconduct and its consequences, refer to the Student Rights and Responsibilities policy available at <https://www.nwpolytech.ca/about/administration/policies/index.html>.

**Note: all Academic and Administrative policies are available on the same page.