NORTHWESTERN POLYTECHNIC

DEPARTMENT of Science

COURSE OUTLINE – Fall 2025

CS 4040 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: Dr. Brian Redmond
OFFICE: J206
OFFICE HOURS: TBD

PHONE: 780 539-2982
E-MAIL: bredmond@nwpolytech.ca

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:

CS2040 – Algorithms I (3)

REQUIRED TEXT/RESOURCE MATERIALS:

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

DELIVERY MODE(S):

Lectures: Tuesdays and Thursdays 11:30 AM – 12:50 PM in H211
Seminars: Fridays 2:30 PM – 4:20 PM in E302

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LEARNING OUTCOMES:

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:

Homework	26%
Midterm	24%
Final	50%
Total:	100%

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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
L1	Tues. Sept. 2	Introduction/Review	0.1, 0.2
L2	Thurs. Sept. 4	Introduction/Review	0.3, 0.4
S1	Fri. Sept. 5	Worksheet 1	
L3	Tues. Sept. 9	Finite Automata	1.1
L4	Thurs. Sept. 11	Nondeterminism	1.2
S2	Fri. Sept. 12	Worksheet 2	
L5	Tues. Sept. 16	Regular Expressions	1.3
L6	Thurs. Sept. 18	Nonregular Languages	1.4
S3	Fri. Sept. 19	Worksheet 3	
L7	Tues. Sept. 23	Context-Free Grammars	2.1
L8	Thurs. Sept. 25	Pushdown Automata	2.2
S4	Fri. Sept. 26	Worksheet 4	
	Tues. Sept. 30	TR Day – no classes	
L9	Thurs. Oct. 2	Non-Context-Free Languages	2.3

S5	Fri. Oct. 3	Worksheet 5	
L10	Tues. Oct. 7	Turing Machines	3.1
L11	Thurs. Oct. 9	TM Variants	3.2
S6	Fri. Oct. 10	Worksheet 6	
L12	Tues. Oct. 14	The Definition of Algorithm	3.3
L13	Thurs. Oct. 16	Decidable Languages	4.1
S7	Fri. Oct. 17	Worksheet 7	
L14	Tues. Oct. 21	Undecidability	4.2
L15	Thurs. Oct. 23	Undecidable Problems from Language Theory	5.1
S8	Fri. Oct. 24	Worksheet 8	
L16	Tues. Oct. 28	A Simple Undecidable Problem	5.2
L17	Thurs. Oct. 30	Mapping Reducibility	5.3
S9	Fri. Oct. 31	Worksheet 9	
L18	Tues. Nov. 4	Review	
L19	Thurs. Nov. 6	Midterm	
S10	Fri. Nov 7	Worksheet 10	
	Tues. Nov. 11	Fall Break – no classes	
	Thurs. Nov. 13		
	Fri. Nov. 14		
L20	Tues. Nov. 18	Measuring Complexity	7.1
L21	Thurs. Nov. 20	The Class P	7.2
S11	Fri. Nov. 21	Worksheet 11	
L22	Tues. Nov. 25	The Class NP	7.3
L23	Thurs. Nov. 27	NP-Completeness	7.4
S12	Fri. Nov. 28	Worksheet 12	
L24	Tues. Dec. 2	Additional NP-Complete Problems	7.5

L25	Thurs. Dec. 4	Relativization	9.2
S13	Fri. Dec. 5	Worksheet 13	
L26	Tues. Dec. 9	Turing Reducibility	6.3
L27	Thurs. Dec. 11	Review	

Final exam period: Saturday, December 13 – Saturday, December 20, 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.