Ahmedabad University

Course	CSE525 Theory of Computing	Semester	Monsoon Semester 2024
Faculty Name(s)	Souvik Roy	Contact	souvik.roy@ahduni.edu.in
School	SEAS	Credits	3
GER Category:		Teaching Pedagogy Enable:NO	P/NP Course: Can not be taken as P/NP

Schedule

Section 1	01:00 pm to 02:30 pm	Thu	01-08-24 to 26-11-24
	01:00 pm to 02:30 pm	Tue	01-08-24 to 26-11-24
Section 2	02:30 pm to 04:00 pm	Tue	01-08-24 to 26-11-24
	02:30 pm to 04:00 pm	Thu	01-08-24 to 26-11-24

Prerequisite	CSC210 Data Structures and Algorithms/CSE210 Data Structures and Algorithms & CSC310 Advanced Data Structures and Algorithms/CSE310 Advanced Data Structures and Algorithms & MAT101 Discrete Mathematics
Antirequisite	Not Applicable
Corequisite	Not Applicable
Course Description	This course gives an introduction to theory of automata, formal languages and computational complexity. In particular, the content includes deterministic and non-deterministic finite automata, pushdown automata, Turing machines, decidable and undecidable computation problems. Topics will include some aspects of computational complexity. Polynomial (P) and non-deterministic polynomial (NP) complexity class of algorithms.

Course Objectives	The goal of the course is an understanding of what is computation, what are its limits, what are the open problems connected with it. Understanding of concepts of practical importance, like regular expressions, undecidability, tractability or intractability of computational problems. Ability to understand and be able to prove important theorems in this area.
Learning Outcomes	By the end of semester a student will understand concepts like "computable function", will know about long standing open problem of Polynomial class vs Non-deterministic Polynomial class and will be aware of the theoretical limits of various computations. Students will also practice proofs by induction, will understand Turing reducibility and many other concepts that form a foundation of the theory of computation.
Pedagogy	The course will be conducted in the form of short explanations, lectures, followed by solving problems.
Expectation From Students	Students are expected to maintain their own notes from the lectures, they are to take active part in the sessions, asking questions if something is not clear, answering questions from the teacher and other students, taking part in discussions. There will be possibility to discuss problems in the LMS forum.

Assessment/Evaluation	• Mid-Semester Examination:
	  ◦ Written - 30%
	• End Semester Examination:
	  ◦ Written - 30%
	• Other Components:
	  ◦ Assignment - 20%
	  ◦ Quiz - 20%

Attendance Policy	As per Ahmedabad University Policy.
Project / Assignment Details	There will be four graded assignments over the course of the whole course.
Course Material	
Additional Information	

Session Plan

NO.	TOPIC TITLE	TOPIC & SUBTOPIC DETAILS	READINGS,CASES,ETC.	ACTIVITIES	IMPORTANT DATES
1	Introduction,	Review of sets, sequences, functions and relations, graphs, strings and languages, Boolean logic	ch. 0 , slides, lecture notes		
2	Introduction	Review of proofs: by construction, by induction and by contradiction	ch. 0 slides, lecture notes		
3	Finite Automata	Formal definition of finite automaton, definition of computation	ch. 1.1, slides		
4	Finite Automata	Nondeterministic finite automaton	ch. 1.2, slides		
5	Regular expressions	Equivalence with finite automata	ch. 1.3, slides		
6	Limits of finite autmata and regular languages	Pumping Lemma for regular languages	ch. 1.4, slides		
7	Review	Solving problems, projects		quiz 1	
8	Pushdown Automata	Context –free grammars, Chomsky normal form	ch. 2.1, slides		
9	Pushdown Automata	Examples, equivalence with CFG	ch. 2.2, slides		
10	Limits of pushdown automata and context-free languages	Pumping Lemma for context-free languages	ch. 2.3, slides		
11	Review session	Solving problems, discussing projects		quiz 2	

12	Turing Machine	Formal definition, examples	ch. 3.1, slides		
13	Turing Machine	Multitape, enumerators, equivalence with other models	ch. 3.2, slides		
14	Turing Machine	Church-Turing thesis, definition of algorithm, Hilbert's problems	ch. 3.3, slides		
15	Decidability	Decidable languages	ch. 4.1, slides		
16	Undecidability	Diagonalization, Turing-unrecognizable language	ch. 4.2, slides		
17	Turing reducibility	Mapping reducibility	ch. 5.3, slides		
18	Review session	Solving problems, projects		quiz 3	
19	Time complexity	Review of Big-O, small-o notation, time complexity of the previous models of computation	ch. 7.1, slides		
20	Time complexity	class P	ch. 7.2, slides		
21	Time complexity	Class NP	ch. 7.3, slides		
22	Time complexity	NP-completeness	ch. 7.4, lecture notes		
23	Time complexity	Cook-Levin Theorem	ch. 7.4, lecture notes		
24	Time complexity	NP-complete problems	ch. 7.5, lecture notes		
25	Review session	Solving problems, projects,		quiz 4	
26	Space complexty	Sawitch theorem	ch. 8.1		
27	Space complexity	PSpace class and PSpace completeness, other complexity classes, hierarchy theorems	A summary based on ch. 8 and 9		

28	mid-semester examination				
29	Reflection and review				
30	End-semester examination				