



## **COURSE HANDOUT**

**Session:** 2025-2026

**Sub Session:** Semester II (Jan-Jun)

**Course Name:** Theory of Computation (CS 302)

**L/T/P/C:** 3/1/0/4

**Course Incharge:** Mr. Ayan Nandy

**Course Faculty:**

Mr. Ayan Nandy ( ayan.nandy@niituniversity.in )

**Registered Batches:**

B.Tech. - CSE 2022 , CSE 2024

### **Course Description**

In this course, the following topics will be covered - Finite Automata (deterministic and nondeterministic), regular operations. Regular Expression, Equivalence of DFA, NFA and REs, closure properties. Non regular languages and pumping lemma, Minimization of states of DFAs, Myhill-Nerode Theorem. CFGs, Chomsky Normal Form. Non CFLs and pumping lemma for CFLs, PDAs, Equivalence of PDA and CFG. Properties of CFLs, DCFLs, Cocke–Younger–Kasami algorithm for Context Free Grammars. Turing Machines and its variants. Configuration graph, closure properties of decidable and Turing-recognizable languages, decidability, Diagonalization Proof. Undecidability, Halting Problem and its undecidability. Introduction to complexity theory, time complexity, P and NP, SAT, Poly-time Reducibility, NP-completeness, Cook-Levin Theorem, Space Complexity, PSPACE-Completeness.

### **Course Outcomes**

S.No.	Description
CO1	Creating Finite Automata, Context Free Grammars and Turing Machines that accepts/generates languages which are respectively regular, context free and recursive
CO2	Applying the concept of equivalence classes to understand Myhill Nerode Theorem and minimize DFAs
CO3	Applying the method of contradiction to understand pumping and generalized pumping lemma and determine if a language is regular
CO4	Produce proofs to determine whether a recursive language is NP-Complete, PSPACE-Complete
CO5	Understanding diagonalization to prove existence of non-r.e. languages and argue the undecidability of the Halting Problem
CO6	Distinguish between regular, context-free, recursive, recursively enumerable and non-r.e. languages.

### **Course outcome mapping with Programme Outcomes:**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	1	1	1	1	1	2
CO2	3	3	3	2	2	1	1	1	1	1	1	2
CO3	3	3	3	2	2	1	1	1	1	1	1	2
CO4	3	3	3	2	2	2	2	1	2	2	1	2
CO5	3	3	3	2	2	2	2	2	1	1	2	3
CO6	3	3	3	3	2	1	1	1	1	1	1	2
Max.	3	3	3	3	2	2	2	2	2	2	2	3

3 is High, 2 is Moderate, 1 is Low & - is Not Applicable

### **AC Approved Course Content**

The Academic Council approved course content will be filled in this section by the Academic Office.

### **Tentative Lecture Plan/ Activities**

Units	Syllabus Details	Hours required to complete	Course Outcome
1	Introduction to Theory of Computation	1	CO1
2	Deterministic Finite Automata	2	CO1
3	Regular Languages and Closure Properties	1	CO1
4	Non Regular Languages and Pumping Lemma	2	CO1, CO3
5	Generalized Pumping Lemma	1	CO1, CO3
6	Non Deterministic Finite Automata	3	CO1
7	Non-Deterministic Finite Automata with epsilon transitions	1	CO1
8	Regular Expressions	2	CO1
9	Closure properties of Regular Languages	2	CO1
10	Decision Problems concerning Regular Languages	1	CO1
11	Myhill Nerode Theorem	3	CO1, CO2
12	DFA Minimization	1	CO1, CO2
13	Introduction to Context free Grammars	1	CO1, CO6
14	Examples of Context free Grammars, parse trees	1	CO1, CO6
15	Regular Languages are Context Free	1	CO1
16	Chomsky Normal Form	3	CO1, CO6
17	Pumping Lemma for Context Free Languages	2	CO1
18	Closure Properties of CFLs	1	CO1, CO6
19	Decision Algorithms for CFLs	1	CO1, CO6
20	Push Down Automata	1	CO1, CO6
21	Introduction to Turing Machines	3	CO1, CO6
22	Multi-tape Turing machine and Non-Deterministic Turing Machine	1	CO1, CO6
23	Diagonalization and Existence of languages not recursively enumerable	1	CO1, CO5
24	Recursive languages, Halting Problem and its undecidability	2	CO1, CO5
25	Introduction to Computational Complexity	1	CO1, CO4, CO6
26	NP Completeness	2	CO1, CO4, CO6
27	PSPACE Completeness	1	CO1, CO4, CO6
<b>Total lectures/activities required</b>		<b>42*</b>	

\*Number of lectures/activities may vary.

## **Book Details**

### **Text Books**

TB1. Michael Sipser, Introduction to Theory of Computation, 2nd edition, Thomson Course Technology, 2006. ISBN: 0534950973.

### **Reference Books**

RB1. Apostolos Doxiadis, Christos Papadimitriou, Logicomix: An Epic Search for Truth, Bloomsbury Publishing, 2009, ISBN: 9782311102321

RB2. Douglas Hofstadter, Godel, Escher, Bach: an Eternal Golden Braid, Basic Books, ISBN 9780465026562.

### **Online course work/ Massive Open Online Course/ Open source web material**

<https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-080-great-ideas-in-theoretical-computer-science-spring-2008/>

<https://blog.computationalcomplexity.org/2004/06/impagliazzos-five-worlds.html>

<https://blog.computationalcomplexity.org/2009/04/letter.html>

<https://ocw.mit.edu/high-school/humanities-and-social-sciences/godel-escher-bach/>

[http://www.people.vcu.edu/\(tilde\)elhaij/GEB/Notes/index.html](http://www.people.vcu.edu/(tilde)elhaij/GEB/Notes/index.html)

<http://www.felderbooks.com/papers/godel.html>

### **Evaluation Scheme (Theory/ Practical)**

Evaluation Component	Exam Month	Exam Duration (in Hrs)	Mode of Examination	Weighted Marks
Attendance	Not Applicable	Not Applicable	Not Applicable	10.00
Quiz 1	January	0.5	Pen-Paper with closed book	5.00
Quiz 2	February	0.5	Pen-Paper with closed book	5.00
Quiz 3	March	0.5	Pen-Paper with closed book	5.00
Quiz 4	April	0.5	Pen-Paper with closed book	5.00
Mid Semester Examination	March	1.5	Pen-Paper with closed book	30.00
Comprehensive Examination	May	3	Pen-Paper with closed book	40.00

### **Mode of Tutorial**

Problem Sets will be shared with the students every weekend. Students will work on those problems and discuss their doubts during the Tutorial sessions.

### **List of Tentative Tutorial**

Problems from the book by Sipser and other resources will be discussed. Problem sets will be uploaded to the learning portal and the doubts will be discussed during the Tutorial sessions.

### **Course outcome mapping with evaluation components:**

CO	Comprehensive Examination	Mid Semester Examination	Quiz 1	Quiz 2	Quiz 3	Quiz 4
CO1	3	3	3	3	3	3
CO2	2	3	2	3	2	2

<b>CO5</b>	3	1	1	1	1	3
<b>CO6</b>	3	1	1	2	3	3
<b>Max.</b>	3	3	3	3	3	3

3 is High, 2 is Moderate, 1 is Low & - is Not Applicable

### **Make up Policy**

Students who are likely to miss a component of evaluation due to any genuine reason may be given a make-up for that component by the Course In-Charge. The students are required to approach the Course In-Charge immediately for the same before the conduct of the evaluation component. It is the responsibility of the student to approach the Course In-Charge. The Course In-Charge will not allow makeup, if a student approaches 7 days after the evaluation component (Student Handbook R 35).

### **Plagiarism**

We are committed to uphold the standards of academic integrity and honesty. Plagiarism in any form is unacceptable and will be treated seriously (Student Handbook R 49).

### **Grading Policy**

The marks obtained in all evaluation components will be aggregated, and the total will be converted into a letter grade or report in accordance with NIIT University's guidelines. Grading is relative and is generally aligned with the class average. Mid-Semester grades will be announced after the evaluation of the Mid-Semester Examination, as outlined in the Student Handbook (R 40 and R 41).

### **University Attendance Policy**

As per attendance policy of NIIT University. For more details, kindly refer to the attendance policy in the student handbook.

### **Consultation Hours**

10am to 12:30pm, every Wednesday