COURSE CONTENT

FORMAL LANGUAGES AND AUTOMATA THEORY

IV Semester : CSD
V Semester : CSE / CSM

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
24X0504	Core	3	0	0	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisites: Data Structures								

Course Overview:

This course provides a comprehensive foundation in **Automata Theory, Formal Languages, and Computability**, which form the theoretical backbone of computer science. It introduces abstract models of computation, their capabilities, limitations, and applications in areas such as compiler design, text processing, and problem solvability.

Course Objectives:

- To introduce the foundational concepts of automata theory, formal languages, and their role in computation.
- To develop the ability to design finite automata, regular expressions, and grammars for language representation.
- To familiarize students with context-free grammars, pushdown automata, and their applications in parsing.
- To provide knowledge of normal forms, closure properties, and pumping lemmas for analyzing languages.
- To explain Turing machines, undecidability, and computational limits of formal models.

Course Outcomes: After Completion of the Course, Students should be able to

- Apply the fundamental concepts of finite automata, regular languages, and their conversions for solving computational problems.
- Construct and analyze regular expressions, automata, and grammars for representing formal languages.
- Design context-free grammars and pushdown automata for language recognition and parsing applications.
- Demonstrate the use of normal forms, closure properties, and pumping lemmas for proving properties of languages.
- Evaluate the computational power of Turing machines and analyze decidability and undecidability problems in automata theory.

UNIT - I: Introduction to Finite Automata: Structural Representations, Automata and Complexity, the Central Concepts of Automata Theory – Alphabets, Strings, Languages, Problems. Non deterministic Finite Automata: Formal Definition, an application, Text Search, Finite Automata with Epsilon-Transitions. Deterministic Finite Automata: Definition of DFA, How A DFA Process Strings,

The language of DFA, Conversion of NFA with €-transitions to NFA without €-transitions. Conversion of NFA to DFA.

UNIT - II: Regular Expressions: Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions, Conversion of Finite Automata to Regular Expressions. Pumping Lemma for Regular Languages, Statement of the pumping lemma, Applications of the Pumping Lemma. Closure Properties of Regular Languages: Closure properties of Regular languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata.

UNIT - III: Context-Free Grammars: Definition of Context-Free Grammars, Derivations Using a Grammar, Leftmost and Rightmost Derivations, the Language of a Grammar, Sentential Forms, Parse Tress, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages. Push Down Automata: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDA's and CFG's, Acceptance by final state, Acceptance by empty stack, Deterministic Pushdown Automata. Conversion of CFG to PDA.

UNIT - IV: Normal Forms for Context- Free Grammars: Eliminating useless symbols, Eliminating €- Productions. Chomsky Normal form Griebech Normal form. Pumping Lemma for Context-Free Languages: Statement of pumping lemma, Applications Closure Properties of Context-Free Languages: Closure properties of CFL's, Decision Properties of CFL's Turing Machines.

UNIT - V:

Introduction to Turing Machine,Formal Description, Instantaneous description, The language of a Turing machine Types of Turing machine: Turing machines and halting Undecidability: Undecidability, A Language that is Not Recursively Enumerable, An Undecidable Problem That is RE, Undecidable Problems about Turing Machines, Recursive languages, Properties of recursive languages, Post's Correspondence Problem, Modified Post Correspondence problem, Other Undecidable Problems, Counter machines.

TEXT BOOKS:

1.Introduction to Automata Theory, Languages, and Computation, 3rd Edition, John E.Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education.

2.Theory of Computer Science – Automata languages and computation, Mishra and Chandra shekaran, 2nd edition, PHI.

REFERENCE BOOKS:

1. Introduction to Languages and The Theory of Computation, John C Martin, TMH.
2. Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
3. A Text book on Automata Theory, P. K. Srimani, Nasir S. F. B,

Cambridge University Press

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ELECTRONIC RESOURCES:

1. https://www.geeksforgeeks.org/theory-of-computation/
2. https://www.tutorialspoint.com/automata_theory/
3. https://web.stanford.edu/class/cs154/
4. https://nptel.ac.in/courses/106/106/106106049/

MATERIALS ONLINE:

1. Course template
2. Tutorial question bank
3. Tech talk and Concept Video topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. E-Learning Readiness Videos