2/4 B.Tech. SECOND SEMESTER
THEORY OF COMPUTATION

CS4T1	**Required**	**Credits: 4**

Lecture: 4 periods/week	**Internal assessment: 30 marks**
Tutorial: 1 period /week	**Semester end examination: 70 marks**

Course context and Overview: Theory of computation teaches how efficiently problems can be solved on a model of computation, using an algorithm. It is also necessary to learn the ways in which computer can be made to think. Finite state machines can help in natural language processing which is an emerging area.

Prerequisites: Discrete Mathematics, Regular Languages and Finite Automata & Mathematics for Computation Theory

Objectives:

1. To introduce the fundamental mathematical and computational principles are the foundation of computer science.
2. To address students' misconceptions about computer science theory.
3. Explain the theoretical limits on computational solutions of undecidable and inherently complex problems.
4. Understand formal definitions of machine models.

Learning Outcomes:

Ability to:

1. Understand the basic terminology of finite automation.
2. Convert among equivalently notations for a language including among DFA's, NFA's and regular expressions and between PDA's and CFG's.
3. Determine a languages place in Chomsky hierarchy.
4. Design a Turing machine for a given problem.
5. Understand various complexity classes like PNP.

UNIT I

Fundamentals:

Set, Representation of set, Types of sets, Operations on sets, Relation, Representation of a relation, Properties of a relation, Basic terminology of trees and graphs, Principle of mathematical induction, Strings, Alphabets, Languages, Operations on strings and languages, Finite state machine, definitions, Finite automaton model, Acceptance of strings and languages, Deterministic finite automaton (DFA) and Non-deterministic finite automaton (NFA), Transition diagrams and Language recognizers.

UNIT II

Finite State Automata:

Acceptance of languages, Equivalence of NFA and DFA, NFA to DFA conversion, NFA with $\in$ - transitions, Significance, Conversion of NFA with $\in$ - transitions to NFA without $\in$ - transitions, Minimization of finite automata, Equivalence between two DFA's, Finite automata with output - Moore and Mealy machines, Equivalence between Moore and Mealy machines, conversion of Moore to Mealy and Mealy to Moore.

UNIT III

Regular Expressions and Regular Languages:

Regular sets, Regular expressions, Operations and applications of regular expressions, Identity rules, Conversion of a given regular expression into a finite automaton, Conversion of finite automata into a regular expression, Pumping lemma for regular sets, Closure properties of regular sets (proofs not required).

UNIT IV

Grammar Formalism:

Definition of a grammar, Language of a grammar, Types of grammars, Chomsky classification of languages, Regular grammars, Right linear and left linear grammars, Conversion from left linear to right linear grammars, Equivalence of regular grammar and finite automata, Inter conversion.

UNIT V

Context Free Grammars and Languages:

Context free grammars and languages, Derivation trees, Leftmost and rightmost derivation of strings and Sentential forms, Ambiguity, left recursion and left factoring in context free grammars, Minimization of context free grammars, Normal forms for context free grammars, Chomsky normal form, Greibach normal form, Pumping lemma for context free languages, Closure and decision properties of context free languages.

UNIT VI

Pushdown Automata:

Pushdown automata, definition, model, Graphical notation, Instantaneous descriptions, Acceptance of context free languages, Acceptance by final state and acceptance by empty state and its equivalence, Equivalence of context free grammars and pushdown automata, Inter-conversion, Introduction to deterministic and Non-deterministic pushdown automata .

UNIT VII

Turing Machine:

Turing Machine, definition, model, Instantaneous descriptions, Representation of Turing machines, Design of Turing machines, Types of Turing machines, Computable functions,

Unrestricted grammar, Recursive and recursively enumerable languages and Church’s hypothesis, Context-Sensitive Grammar and introduction to Linear –Bound Automata.

UNIT VIII

Undesirability:

Decidable and un-decidable problems, Universal Turing machine, Halting problem of a Turing machine, Un-decidability of post’s correspondence problem and modified post’s correspondence problem, Turing reducibility, Definition of classes P and NP problems, NP complete and NP hard problems.

Learning Resources

TEXT BOOKS:

1. Formal Languages and Automata Theory by Basavarj S. Anami,Karibasappa K.G, WLEY-INDIA .
2. Theory of Computer Science, Automata languages and computation , 2/e, Mishra, Chandra shekaran, PHI

REFERENCE BOOKS:

1. Introduction to Automata Theory Languages & Computation, 3/e, Hopcroft, Ullman,PEA

Introduction to Theory of Computation, 2/e, Sipser, Thomson