University of Mumbai			
Class: T.E.	**Branch:** Computer Engineering	**Semester:** V	
Subject: Theory of Computer Science (Abbreviated as **TCS**)			
Periods per Week (each 60 min)	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical and Oral	--	--
	Oral	---	--
	Term Work	---	25
	Total	03	125

OBJECTIVES
Objectives of the Course: This course aims to build concepts regarding the fundamental principles of Grammars, Automata Theory, Turing Machines, Push Down Automata, Undecidability and Intractable Problems
PREREQUISITES
Prerequisites: Discrete Structures and Graphs Theory (e.g. Graphs, Trees, Logic and Proof Techniques) and also familiar with common Data Structures, Recursion, and the role of major system components such as Compilers.

Module	Contents	Hours
1	Introduction:alphabets, Strings and Languages, automata and Grammars. Finite. Automata (FA) -its behavior; DFA -Formal definition, simplified notations (state transition diagram, transition table), Language of a DFA. NFA -Formal definition, Language of an NFA. An Application: Text Search, FA with epsilon-transitions, Eliminating epsilon-transitions, Equivalence of DFAs and NFAs.	05
2	Regular expressions (RE) -Definition, FA and RE, RE to FA, FA to RE, algebraic laws for RE, applications of REs, Regular grammars and FA, FA for regular grammar, Regular grammar for FA	03
3	Proving languages to be non-regular - Pumping Lenma, and its applications. Some closure properties of Regular languages -Closure under Boolean operations, reversal, homomorphism, inverse homomorphism, etc. M hill-Nerode Theorem.	03
4	DFA Minimization**.** Some decision properties of Regular languages -emptiness, finiteness, membership, equivalence of two DF As or REs, Finite automata with output.	03

5	Context-free Grammars (CFGs) -Formal definition, sentential forms, leftmost and rightmost derivations, the language of a CFG. Derivation tree or Parse tree-Definition, Relationship between parse trees and derivations. Parsing and ambiguity, Application of CFGs, Ambiguity in grammars and Languages. Simplification of CFGs -Removing useless symbols, epsilon-Productions, and unit productions, Normal forms -CNF and GNF. Proving that some languages are not context free -Pumping lemma for CFLs, applications. Some closure properties of CFLs -Closure under union, concatenation, Kleene closure, substitution, Inverse homomorphism, reversal, intersection with regular set, etc. Some more decision properties of CFLs, Review of some undecidable CFL problems.	10
6	Pushdown Automata (PDA) -Formal definition, behavior and graphical notation, Instantaneous descriptions (Ids), The language of PDA (acceptance by final state and empty stack). Equivalence of acceptance by final state and empty stack, Equivalence of PDAs and CFGs, CFG to PDA, PDA to CFG. DPDAs -Definition, DPDAs and Regular Languages, DPDAs, Multistack DPDAs & NPDAs and CFLs. Languages of DPDAs, NPDAs, and ambiguous grammars	06
7	Turing Machines TM -Formal definition and behavior, Transition diagrams, Language of a TM, TM as accepters deciders and generators. TM as a computer of integer functions, Design of TMs, Programming techniques for TMs - Storage in state, multiple tracks, subroutines, etc. Universal TMs, Variants of TMs -Multitape TMs, Nondeterministic TMs. TMs with semi-infinite tapes, Multistack machines, Simulating TM by computer, Simulating a Computer by a TM, Equivalence of the various variants with the basic model. Recursive and recursively enumerable languages, Properties of recursive and recursively enumerable languages, A language that is not recursively enumerable (the diagonalization language). The universal language, Undecidability of the universal language, The Halting problem, Rice's Theorem, Greibach Theorem, Post's Correspondence Problem (PCP) -Definition, Undecidability of PCP. Context sensitive language and linear bounded automata. Chomsky hierarchy.	10
8	Intractable Problems :The classes P and NP, An NP-complete problem, A Restricted Satisfiability problem, Additional NP-complete problems, Complements of languages in NP,	08

	Problems Solvable in polynomial space, A problem that is complete for PS, Language Classes based on randomization, The complexity of primality testing.	

TEXT BOOKS

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, " Introduction to Automata
Theory, Languages and Computation", Pearson Education.
2. J.C.Martin, "Introduction to languages and the Theory of Computation", TMH.
3. Michael Sipser, "Theory of Computation",Cengage Learning.

REFERENCES

1. O.G.Kakde, "Theory of Computation", LP.
2. Krishnamurthy E.V. , "Introductory Theory of Computer Science", East-West press.

TERM WORK

1. Term Work should consists of at least 04 experiments and 08 assignments (at least one implementation on each machine and at least one assignment on each module).
2. A Term Work should consists of Term Test must be conducted with a weightage of 10 marks.