Electives

MCA-E01 Theory of Computation

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Course Objectives:

Understanding the inherent capabilities and limitations of computers is a fundamental question in computer science. To answer this question, we will define formal mathematical models of computation, and study their relationships with formal languages. Topics will consist of three central areas of the theory of computation: automata, computability, and complexity. Students will also learn that not all problems are solvable by computers, and some problems do not admit efficient algorithms. Throughout this course, they will strengthen their rigorous mathematical reasoning skills.

UNIT – I

Automata-introduction to finite automata, structural representations, automata and complexity, Alphabets, strings, languages, problems, Chomsky hierarchy, Deterministic Finite Automata, non-deterministic Finite Automata, Finite Automata With Epsilon Transition.

Regular Expression and languages- regular expressions, finite automata and regular expressions, applications, algebraic laws, pumping lemma for regular languages, closure properties, equivalence and minimization of automata.

UNIT – II

Context Free Grammars and languages- introduction to context free grammars, parse trees, applications of CFG, ambiguity in grammars and languages.

Pushdown Automata- definition of pushdown automata, languages of a PDA , equivalence of PDA and CFG, deterministic PDA, non-deterministic PDA, properties of context free languages, normal forms, pumping lemma, closure properties, decision properties.

UNIT – III

Turing Machine-problems that computer cannot solve, the turing machine, programming techniques for Turing machines, extensions to the basic turing machine, restricted Turing machines, Turing machines and computers.

UNIT – IV

Un-decidability- a language that is not recursively enumerable, an un-decidable problem that is RE, un-decidable problems about turing machines, other un-decidable problems.

Intractable problems- the classes P and NP, an NP complete problem, a restricted satisfiability problem, additional NP complete problems.

Text Book-

1. J. E. Hopcroft, R. Motwani, and J. D. Ullman, Introduction to Automata Theory,

languages, and computation (2nd ed.), Addison-Wesley, 2001.

Reference Books-

1. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, Elements of the Theory ofComputation (2nd ed.), Prentice-Hall, NJ, 1997.
2. J.A. Anderson, Automata Theory with Modern Applications, CambridgeUniversity Press, 2006.

Course Outcomes:

By the end of the course, students will be able to
CO 1: Understand key notions of computation, such as algorithm, computability,decidability, reducibility, and complexity, through problem solving.
CO 2: Explain the models of computation, including formal languages, grammars andautomata, and their connections.
CO 3: State and explain the Church-Turing thesis and its significance.
CO 4: Analyse and design finite automata, pushdown automata, Turing machines,formal languages, and grammars.
CO 5: Solve computational problems regarding their computability and complexity andprove the basic results of the theory of computation.

Note: In each theory paper, nine questions are to be set. Two questions are to set from each Unit and candidate is required to attempt one question from each unit. Question number nine will be compulsory, which will be of short answer type with 5-10 parts, out of the entire syllabus. In all, five questions are to be attempted.