18MC209FORMAL LANGUAGES AND AUTOMATA THEORY

Course Description and Objectives:

This course focuses on the basic theory of Computer Science and formal methods of computation like Automata theory, Formal languages, Grammars and Turing Machines. In addition, it helps a student to explore the theoretical foundations of computer science from the perspective of formal languages and classify machines by their power to recognize languages.

Course Outcomes:

The student will be able to:

- Analyze the basic properties of formal languages and grammars.
- Differentiate regular, context-free and recursively enumerable languages.
- Create grammars to produce strings from specific language(s).
- Acquire concepts related to the theory of computation and computational models including decidability and intractability.

Skills:

- Design automata, regular expressions and context-free grammars for accepting or generating a certain language.
- Describe the language accepted by an automata or generated by a regular expressionoracontext-freegrammar.
- Transformbetweenequivalentdeterministicandnon-deterministicfiniteautomata, andregularexpressions.
- Minimizefiniteautomataandgrammarsofcontext-freelanguages.

Activities:

- Conversion of NFA to DFA.
- Finding equivalence between finite automata and regular expressions.
- Convert regular grammar to finite automata and vice-versa.
- Simplification of grammar.
- Design a Turing machine for a particular language.

Syllabus

UNIT – 1 **12 Hours**

NFA and DFA**:** Alphabets, Strings and languages, Automata and Grammars, Regular languages, Deterministic finite automata (DFA)-Formal definition, Simplified notation**,** State transition graph, Transition table, Language of DFA; Nondeterministic finite automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of finite automata, Distinguishing one string from other, Myhill-Nerode Theorem, FA with output - Moore and Mealy machine, Equivalence of Moore and Mealy machine, Applications and Limitation of FA.

UNIT – 2 **12 Hours**

REGULAR EXPRESSIONS**:** Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to regular expression, Arden theorem, Non regular languages, Pumping lemma for regular languages, Application of pumping lemma, Closure properties of regular languages, Decision properties of regular languages.

UNIT – 3 **12 Hours**

GRAMMAR FORMALISM**:** Regular grammars-Right linear and left linear grammars, Equivalence between regular linear grammar and FA; Context free grammar, Definition, Examples, Derivation, Derivation trees, Ambiguity in grammar, Inherent ambiguity, Ambiguous to unambiguous CFG, Useless symbols, Simplification of CFGs; Normal forms for CFGs - CNF and GNF, Closure properties of CFLs; Decision properties of CFLs-Emptiness, Finiteness and membership, Pumping lemma for CFLs.

UNIT – 4 **12 Hours**

PUSH DOWN AUTOMATA**:** Description and definition, Instantaneous description, Language of PDA, Acceptance by final state, Acceptance by empty stack, Deterministic PDA, Equivalence of PDA and CFG, CFG to PDA and PDA to CFG, Two stack PDA.

UNIT – 5 **12 Hours**

TURING MACHINES**:** Basic model, Definition and representation, Instantaneous Description, Language acceptance by TM, Computable functions, Types of Turing machines, Universal TM, Church's Thesis, Recursive and recursively enumerable languages, Halting problem, Introduction to undecidability, Undecidable problems about TMs, Post correspondence problem (PCP), Modified PCP.

Text Book:

Hopcroft and Ullman, "Introduction to Automata Theory, Languages and Computation", 2nd Edition, Pearson/Prentice Hall India, 2007.

Reference Books:

1. K.L.P. Mishra and N.Chandrasekaran, "Theory of Computer Science:Automata, Languages and Computation", 2nd Edition, Pearson/Prentice Hall India, 2004.
2. Martin J. C., "Introduction to Languages and Theory of Computations", 2nd Edition, Tata McGraw Hill, 2005.
3. Papadimitrou, C. and Lewis, C.L., "Elements of the Theory of Computation", 2nd Edition, Pearson/Prentice Hall India, 2009.