# FORMAL LANGUAGES & AUTOMATA THEORY

**Course Code: 22CT1113** **L T P C**
**3 0 0 3**

**Course Outcomes:** At the end of the Course the student shall be able to
**CO1:** Explain finite state machines for modeling and their power to recognize the languages.(L2)
**CO2:** Summarize the concept of Regular languages and Converting Regular Expression to Finite Automata (Vice Versa) (L2)
**CO3:** Explain the concept of context free languages and normal forms (L2)
**CO4:** Construct CFG and PDA as well for the given set of languages (L3)
**CO5:** Construct Turing machines for the given set of grammars.(L3)

## UNIT-I (12 Lectures)

**Fundamentals**: Formal Languages, Strings, Alphabets, Languages, Chomsky Hierarchy of languages.
**Finite Automata:** Introduction to Finite State machine, Acceptance of strings and languages, Deterministic finite automaton (DFA) and Non-deterministic finite automaton (NFA), Equivalence of NFA and DFA – Equivalence of NDFAs with and without €-moves, Minimization of finite automata, Equivalence between two DFA's, Finite automata with output – Moore and Mealy machines, conversion of Moore to Mealy and Mealy to Moore
**Learning Outcomes:** At the end of the module the student will be able to
1. describe about Finite Automata Model (L2)
2. translate NFA to DFA and vice versa (L2)
3. translate NFA with €-moves to NFA and DFA (L2)
4. translate Mealy to Moore and Vice-versa (L2)

## UNIT-II (10 Lectures )

**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).
**Learning Outcomes:** At the end of the module the student will be able to
1. describe about Regular Sets and Regular Expressions (L2)
2. relate Regular Expressions and Finite Automata (L2)
3. explain Closure Properties of Regular sets (L2)

## UNIT-III (10 Lectures)

**Regular Grammars:** Definition of a grammar, 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.

**Context Free Grammars**: 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.

**Learning Outcomes:** At the end of the module the student will be able to

1. describe and distinguish about Regular Grammar and Context Free Grammar (L2)
2. recognize Ambiguity of Context Free Grammar (L2)
3. explain Closure Properties of Context Free Grammar (L2)

## UNIT-IV (10 Lectures)

**Pushdown Automata:** Introduction to Pushdown automata, 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 (Proofs not required), Introduction to deterministic pushdown automata.

**Learning Outcomes:** At the end of the module the student will be able to

1. construct a PushDown Automata for a Language (L3)
2. construct PDA and Context Free Grammar (L3)
3. explain deterministic pushdown automata (L2)

## UNIT-V (10 Lectures) Turing

**Machine:** Introduction to Turing Machine, Design of Turing machines, Types of Turing machines, Computable functions, Recursive and recursively enumerable languages, closure properties of recursive and recursively enumerable languages.

**Learning Outcomes:** At the end of the module the student will be able to

1. construct a Turing Machine for a Language (L3)
2. classify Different Types of Turing machines (L2)
3. explain the closure properties of Recursive and Recursively Enumerable languages (L2)

## TEXT BOOKS:

1. John E Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, "*Introduction to Automata Theory Languages and Computation*", 3rd Edition, Pearson Education, 2011.

## REFERENCE BOOKS:


1. Peter Linz, " *An introduction to Formal Languages and Automata*", 6th Edition, Jones & Bartlett, 2016
2. Mishra and Chandrashekaran, "*Theory of Computer Science – Automata Languages and Computation*", 3rd Edition, PHI, 2009
3. K.V.N.Sunitha , N.Kalyani, "*Formal Languages and Automata Theory*", 1st Edition, TMH, 2010
4. Michel Sipser, "*Introduction to Theory of Computation*", 2nd Edition, Thomson, 2012


## WEB REFERENCES:

1. Web Reference: https://swayam.gov.in/nd1_noc19_cs79/preview