## 20CE401 THEORY OF COMPUTATION

**Teaching Scheme**
**Lectures: 03 Hrs/Week**
**Tutorial : 01 Hrs/Week**

**Examination Scheme**
**In Semester: 50 Marks**
**End Semester: 50 Marks**
**Credit: 4**

**Prerequisites:**
      1. Data Structures and Algorithms (20CE302)
      2. Discrete Mathematics (20CE303)

**Course Objectives:**
**To facilitate the learners -**
      1. Recall and understand the basics of mathematical concepts, formal languages and machines.
      2. Understand and design different computational models like finite automata, regular expression, push down automata, context free grammar, turing machine for a given language.
      3. Apply inter conversion between equivalent representations of a language.
      4. Design appropriate computational models

**Course Outcomes:**
**By taking this course, the learner will be able to -**
      1. Apply the knowledge of basics of mathematics and logic for problem understanding, representation and solving
      2. Construct different computation models Finite automata, Regular expression, Push down automata, Context Free Grammar, Turing machine
      3. Evaluate capabilities of computational models by inter-conversion
      4. Design appropriate computational models to solve given problems

**Unit 1: Introduction (06)**

Finite and infinite set. Basic concepts of symbol, alphabet, Kleene Closure and positive Closure of Alphabet, Strings, Empty String, Substring of a string, Concatenation of strings, Formal Language Definition, Finite representation of languages. Concept of Basic Machine and Finite State Machine. Finite Automata (FA): (Deterministic FA, Non-deterministic FA, Є-NFA): Definition.

## Unit 2: Finite Automata (07)

Construction of FA (DFA, NFA, Є-NFA) - Transition Function and language acceptance, Transition graph. Conversion of NFA with Є moves to NFA without Є moves, Conversion of NFA without Є moves to DFA, Direct Conversion of NFA with Є to DFA.

## Unit 3: Regular Expression (07)

Regular Expression (RE): definition and operators, Primitive Regular Expressions, Algebraic Laws of Regular Expressions, Languages Defined by Regular Expressions, Building Regular Expressions, Closure Properties of Regular Languages, Regular expression examples. Inter-conversion of RE and FA, Construction of FA equivalent to RE (RE to Є-NFA, Є-NFA to DFA). Construction of RE equivalent to FA using Arden's Theorem. Pumping Lemma for Regular languages, Limitations of FA.

## Unit 4: Context Free Grammar and Languages (07)

Grammar: Definition, representation of grammar. Context Free Grammar (CFG) - Definition, Derivation – Leftmost, Rightmost, sentential form, parse tree, ambiguous grammar and removing ambiguity from grammar, Simplification of CFG, Normal Forms - Chomsky normal form, Greibach normal form, Closure properties of Context Free Languages (CFL), Decision properties of CFL, Chomsky hierarchy. Regular grammar- Definition, left linear, right linear grammar, Applications of grammar.

## Unit 5: Push Down Automata (07)

Push Down Automata (PDA): Definition, Notations, Transition Table form, Types of PDA (Deterministic PDA and Non Deterministic PDA), acceptance by final state, acceptance by empty stack, Construction of PDA (DPDA, NPDA), Instantaneous Description of PDA. Equivalence of PDA and CFG - Grammar to PDA conversion, Applications of PDA.

**Unit 6: Turing Machine (08)**

Turing machine (TMs): Formal Definition, TM Instantaneous Description, Transition Function, Languages of TM, Turing Machine and halting, Deterministic Turing Machines (DTM), Construction of DTM. Universal Turing Machine (UTM), Church-Turing hypothesis, Comparison between FA, PDA and TM. Turing Machine Halting Problem. TM's as acceptors, Recognizing Languages with TM's.

**Text Books:**

1. Hopcroft J., Motwani R., Ullman J., "Introduction to Automata Theory, Languages and Computations", Third edition, 2008, Pearson Education Asia. ISBN: 9788131720479

2. Michael Sipser, "Introduction to The Theory of Computation", Third edition, 2017 Thomson Course Technology, ISBN: 9781131525296

**Reference Books:**

1. Daniel Cohen., "Introduction to Computer Theory", Second edition, 2011, Wiley Publications (India) ISBN: 9788126513345

2. H.R. Lewis, C. H. Papadimitrou, "Elements of the Theory of Computation", Second edition, 2006, Prentice Hall Inc. ISBN: 8131703878

3. John C Martin. "Introduction to Language and Theory of Computation", Third edition, 2012, Tata McGraw- Hill, ISBN: 978007660489

4. Vivek Kulkarni, "Theory of Computation", Oxford university edition, 2013, ISBN 13:9780198084587

5. K. L. P Mishra, N. Chandrashekaran (2003), Theory of Computer Science-Automata Languages and Computation, 2nd edition, Prentice Hall of India, India.

**Suggestive List of Tutorials:**

1. Design of Finite state machine

2. Design Deterministic Finite Automata
3. NFA design and NFA to DFA conversion
4. Design of Regular Expression from Language
5. Converting RE to NFA with null moves and then NFA with null moves to NFA without null moves
6. Formal language and CFG interconversion
7. Simplification / standardization of CFG to Normal Forms
8. Design of Push down Automata
9. Design of Turing Machine