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| **CS21003: Automata Theory and Formal Languages**  **School of Computer Engineering,**  **KIIT Deemed to be University, Bhubaneswar**  **Session: Aug-Dec, 2023**  **Credit: 4** |

**Instructor:**

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**Course Objective:**

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| * To know about Chomsky hierarchy for organizing languages |
| * To introduce concepts in automata theory and theory of computation |
| * To identify different formal language classes and their relationships |
| * To design grammars and recognizers for different formal languages |
| * To understand undecidability and decide on languages that are undecidable |

**Day Wise Lesson Plan:**

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| **Topics** | **Lecture**  **No.** |
| **MODULE-1** | |
| Preliminaries: Set, Symbol, Alphabet, String, Functions and Relations on Strings, Language, Formal Languages |  |
| Introduction to Automata, Classification of Automata and languages |  |
| Description and definition of Deterministic Finite Automata (DFA) |  |
| DFA with examples Lect.-1 |  |
| DFA with examples Lect.-2 |  |
| DFA with examples Lect.-3 |  |
| DFA with examples Lect.-4 |  |
| DFA with examples Lect.-5 |  |
| Description and definition of Non- Deterministic Finite Automata (NFA), DFA vs. NFA  Design of NFA Examples Lect.-1 |  |
| Design of NFA Examples Lect.-2,  Language accepted by DFA, NFA (without -transitions) |  |
| Languages accepted by NFAs (with -transitions) |  |
| Conversion from NFA without - transitions to DFA |  |
| Conversion from NFA with-transitions i.e.- NFA to DFA |  |
| Minimization of DFA |  |

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| **MODULE-2** | |
| Description of Regular Expression (RE) |  |
| Conversion from Regular expression to NFA |  |
| Conversion from DFA to RE using State Elimination Method |  |
| Closure properties of Regular language Lect.-1 |  |
| Closure properties of Regular language Lect.-2 |  |
| Pumping lemma for Regular Language |  |
| Proof a language is regular or not by Pumping Lemma |  |
| **MODULE-3** | | |
| Description of Regular grammar with examples Lect.-1 |  | |
| Regular grammar with examples Lect.-2 |  | |
| Conversion between Right Linear Grammar (RLG), Left Linear Grammar (LLG) And vice-versa |  | |
| **MID SEMESTER** | | |
| Context Free Grammar (CFG) and Context Free Languages (CFL) |  | |
| Find Leftmost Derivation (LMD), Rightmost Derivation (RMD), Derivation Tree of String from a given Grammar |  | |
| Ambiguous Grammar and Check whether the grammar is ambiguous or not.  Inherently Ambiguous Grammar and Example |  | |
| Conversion from Ambiguous to Unambiguous Grammar |  | |
| Conversion from Context free languages (CFL) to Context free Grammar(CFG) and Find Languages generated by CFG |  | |
| Simplification of CFG i.e. Simplified Grammar   1. Removal of - production 2. Removal of Unit production 3. Removal of Useless symbol |  | |
| More examples of Simplification of CFG |  | |
| Description of Chomsky Normal Form(CNF)  Conversion from CFG to CNF examples |  | |
| Conversion from CFG to CNF more examples |  | |
| Description of Greibach Normal Form(GNF)  Conversion from CFG to GNF examples |  | |
| Conversion from CFG to GNF more examples |  | |

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| **MODULE-4** | |
| Introduction to PDA |  |
| PDA with examples Lect.-1 |  |
| PDA with examples Lect.-2 |  |
| Instantaneous Description (ID) of PDA |  |
| Conversion from CFG to PDA |  |
| Pumping lemma theorem for CFL |  |
| Closure Properties of CFL Lect.-1 |  |
| Closure Properties of CFL Lect.-2 |  |
| **MODULE-5** | |
| Introduction to Turing Machine (TM) |  |
| Turing Machine Examples with examples Lect.-1 |  |
| Turing Machine Examples with examples Lect.-2  Instantaneous Description (ID) of TM |  |
| Recursive Languages vs. Recursively Enumerable Languages  Chomsky classification of Grammar & Languages. |  |
| Introduction to Undecidability, Undecidable problems about TMs |  |
| **END SEMESTER** | |

**Course Outcome:** At the end of the course, the students will be able to:

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| CO1: | Acquire a fundamental understanding of the core concepts in automata theory and formal languages |
| CO2: | Design finite automata or regular expression for any tokenization task |
| CO3: | Construct a context free grammar for parsing any language |
| CO4: | Design Turing machine for any language |
| CO5: | Conclude the decidable / undecidable nature of any language |
| CO6: | Apply mathematical and formal techniques for solving real-world problems |

**Text books:**

Introduction to automata theory, languages and computations, John E.Hopcroft, Jeffery D.Ullman, Pearson Education, 3rd Edition. ([PDF](https://drive.google.com/file/d/1r9uSSlZR6Vmy_7d5euMenGe7HmMagtmL/view?usp=sharing))

**Reference Books:**

1. An Introduction to Formal Language and Automata, Peter Linz, Jones & Bartlett Publishers, 6th Edition. ([PDF](https://drive.google.com/file/d/19wuWAkdxpbW9VlRhG21YS7vVuHQMuV8z/view?usp=sharing))
2. Elements of the theory of computation, Lewis, Harry R. and Christos H. Papadimitriou Prentice- Hall Englewood, 2nd Edition. ([PDF](https://drive.google.com/file/d/1ji2UXIKEXJy-ZbyLJAqroLamiNND2lY7/view?usp=sharing))
3. Introduction to the Theory of Computation, Michel Sipser, Thomson Brooks/Cole, 2nd Edition. ([PDF](https://drive.google.com/file/d/1n88zmFgNc3xI3-EZbjNOkSFNtHSwtjXV/view?usp=sharing))
4. Theory of computer science by KLP Mishra & N. Chandra Sekharan ,PHI, 3rd edition. ([PDF](https://drive.google.com/file/d/1CajsOUeTqZOWJNj1PC85ruBoDEen6tFL/view?usp=sharing))

**Online Resources:**

1. <https://nptel.ac.in/courses/111/103/111103016/:by> Dr.K.V.Krishnaand, Dr.D.Goswami, IIT Guwahati
2. <https://nptel.ac.in/courses/106/106/106106049/:by> Prof.K.Krithivasan, IIT Madras
3. <https://nptel.ac.in/courses/106/105/106105196/:by> Prof.S.Mukhopadhyay, IIT Kharagpur
4. https://www.ics.uci.edu/∼goodrich/teach/cs162/notes/:by Prof.M.T.Goodrich, University of California, Irvine, USA

**Activity Calendar:**

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| **ACTIVITY SL.NO.** | **TYPE** | **TENTATIVE DATE** | **MARKS** | **CO** |
|  | Class Test-1 | 25th August-30th August | 5 | CO1 |
|  | Assignment-1 | 15th September-20th September | 5 | CO2 |
|  | Quiz-1 | 5th October-10th October | 5 | CO3 |
| **MID SEM EXAM (16th October-21st October)** | | | | |
|  | Class Test-2 | 10th November-15th November | 5 | CO4 |
|  | Assignment-2 | 25th November-30th November | 5 | CO5 |
|  | Quiz-2 | 5th December-9th December | 5 | CO6 |
| **END SEM EXAM (18th December-23rd December)** | | | | |

**Grading Policy:**

* Assignments/quizzes/activities: **30 Marks**
* Mid-semester exam: **20 Marks**
* End-semester exam: **50 Marks**

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