**Shyama Prasad Mukherji College**

**Teaching Plan**

**Course and Year:** B.Sc (H) CS 3rd Year

**Semester:** V

**Taught individually or shared:** Individual

**Paper:** Theory of Computation

**Faculty:** Dr. Shweta Tyagi

**No. of Classes** (per week)**:** 5 lectures + 1 Tutorial (6)

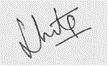
**Course Objective**

This course introduces formal models of computation, namely, finite automaton, pushdown automaton, and Turing machine; and their relationships with formal languages. Students will also learn about the limitations of computing machines.

| **Readings (in APA format)/References/E-Links** | |
| --- | --- |
| **Unit** | **References** |
| Languages | [1] |
| Regular Languages and Finite Automata | [1] |
| Regular Languages | [1] |
| Non-Regular Languages and Context Free Grammars | [1] |
| Context-Free Languages (CFL) and Pushdown Automata (PDA) | [1] |
| Turing Machines and Models of Computations | [2] |
| **References:** | |
| 1. [1] Daniel I.A. Cohen, Introduction to computer theory – John Wiley (1996 2nd Edition). 2. [2] Lewis & Papadimitriou, Elements of the theory of computation – II Edition PHI 1997. 3. [3] Hoperoft, Aho, Ullman, Introduction to Automata theory, Language & Computation 3rd Edition 2006, Pearson Education. 4. [4] P. Linz, An Introduction to Formal Language and Automata, Publication Jones Bartlett, 4th edition 2006 5. [5] Michael Sipser, Introduction to the Theory of Computation, Thomson Press (India) Ltd (1 December 2008) 6. [6] John C. Martin, Introduction to Languages and The Theory of Computation, McGraw-Hill Education, 4th edition 2010 | |
| **E-links:** | |
| https://www.tutorialspoint.com/automata\_theory   1. https://www.javatpoint.com/automata-tutorial | |
| **No of classes required to complete the unit (approx.): 60L**  **Unit I (5L)**  Languages: Alphabets, String, Language, Basic operations on  language, Concatenation, Union, Kleene Star  **Unit II (12L)**  Regular Languages and Finite Automata:   1. Regular expressions 2. Deterministic finite automata (DFA)   **Unit III (15L)**  **Regular Languages:**   1. Non-deterministic finite automata (NFA) 2. Relationship between NFA and DFA 3. Transition graphs (TG) 4. Properties of regular languages 5. The relationship between regular languages and finite automata (Converting RE into FA and vice-versa) 6. Kleene’s theorem   **Unit IV (10L)**  **Non-Regular Languages** and **Context Free Grammars:**   1. Pumping lemma for regular grammars   (Excluding Myhill-Nerode theorem & Quotient Languages)   1. Context-free grammars (CFG), parse tree   (Excluding Lukasiewicz notation)  **Unit V (10L)**  **Context-Free Languages (CFL) and**  Pushdown Automata (PDA):  a) Deterministic and non-deterministic pushdown automata  b) Grammatical Format  (Including killing A (null) productions, killing unit productions, Chomsky normal form (CNF), leftmost derivation)  c) Pumping lemma for CFL  d) Properties of CFL  (Excluding mixing context-free and regular languages)  **Unit VI (8L)**  Turing Machines and Models of Computations:   1. Simple Turing machine (configuration and computation) 2. Decidability (Church Turing thesis, universal Turing machine, halting problem) | |
| **Methodology of Teaching:** Lecture, Discussion, Problem Solving, Presentation | |
| **ASSESSMENT**: 2 Class Test + 1 Assignment  **Tentative date of assessments/ assignments (time frame):** Class Test 1: 2nd week of Sep  Class Test 2: 3rd week of Oct  Assignment: 4th week of Sep  **Criteria of Assessment:** Written test, Assignment, Solve previous year question papers | |

| **Lecture No** | **Topics/Sub-topics to be covered** | **Methodology**  **Lec (L)/Tut (T)** | **Ref./Text Book** | **Status** |
| --- | --- | --- | --- | --- |
| **Objective: To provide the introduction of theory of computation and the basic concepts related to languages and machines** | | | | W1 |
| L1 | Introduction to defining Languages, Alphabets, String, String operations | L | 1 |
| L2 | Language, Basic Operations on Language | L | 1 |
| L3 | Kleene Closure, Positive Closure | L | 1 |
| L4 | Examples | L | 1 |
| L5 | Problems Discussion | T |  |
| **Objective: To explain regular languages and Finite Automaton** | | | | W2 |
| L6 | Regular Expressions, Definition and Examples | L |  |
| L7 | Regular Expressions Examples | L | 1 |
| L8 | Regular Expressions Examples | L | 1 |
| L9 | Problems Discussion | T |  |
| L10 | Problems Discussion | T |  |
| **Objective: To discuss the relation between regular language, transition graph, FA and NFA** | | | | W3 |
| L11 | Deterministic Finite Automata, Definition and Examples | L | 1 |
| L12 | Deterministic Finite Automata Examples | L | 1 |
| L13 | Deterministic Finite Automata Examples | L | 1 |
| L14 | Problems Discussion | T |  |
| L15 | Problems Discussion | T |  |
| **Objective: To understand machines: Transition graphs and Deterministic and Non-Deterministic Finite Automaton** | | | | W4 |
| L16 | Non-deterministic finite automata (NFA) | L | 1 |
| L17 | Relationship between NFA and DFA | L | 1 |
| L18 | Transition graphs (TG) | L | 1 |
| L19 | Examples | L | 1 |
| L20 | Problems Discussion | T | 1 |
| **Objective: To describe the closure properties of regular languages and relationship between regular languages and finite automata** | | | | W5 |
| L21 | Properties of regular languages | L | 1 |
| L22 | Properties of regular languages | L | 1 |
| L23 | The relationship between regular languages and finite automata | L | 1 |
| L24 | The relationship between regular languages and finite automata | L | 1 |
| L25 | Problems Discussion | T | 1 |
| **Objective: To explain Kleene’s theorem for understanding the relation among FA, Transition graphs, Regular languages and NFA** | | | | W6 |
| L26 | Kleene’s Theorem- Part 1 | L | 1 |
| L27 | Kleene’s Theorem- Part 2 | L | 1 |
| L28 | Kleene’s Theorem- Part 3 | L | 1 |
| L29 | NFA and Kleene’s Theorem | L | 1 |
| L30 | Problems Discussion | T |  |
| **Objective: To explain the concept of pumping lemma for regular languages** | | | | W7 |
| L31 | Pumping lemma for regular grammars | L | 1 |
| L32 | Pumping lemma for regular grammars | L | 1 |
| L33 | Examples | L | 1 |
| L34 | Problems Discussion | T |  |
| L35 | **Class Test 1** |  |  |
| **Objective: To introduce and explain the Context-free languages and Parse Tree** | | | | W8 |
| L36 | Context-free grammars (CFG) | L | 1 |
| L37 | Context-free grammars (CFG) examples | L | 1 |
| L38 | Examples | L | 1 |
| L39 | Parse tree | L | 1 |
| L40 | Problems Discussion | T |  |
| **Objective: To further provide the details and working of Deterministic and Non-deterministic Pushdown Automata** | | | | W9 |
| L41 | Deterministic and non-deterministic pushdown automata | L | 1 |
| L42 | Deterministic and non-deterministic pushdown automata | L | 1 |
| L43 | Problems Discussion | T |  |
| L44 | Grammatical Format: Including killing A (null) productions, Killing unit productions | L | 1 |
| L45 | Grammatical Format: Chomsky normal form (CNF), Leftmost derivation | L | 1 |
| **Objective: To provide the details of the pumping lemma for CFL** | | | | W10 |
| L46 | Pumping lemma for CFL | L | 2 |
| L47 | Properties of context free languages | L | 2 |
| L48 | Examples | L | 2 |
| L49 | Problems Discussion | T |  |
| L50 | **Class Test 2** |  |  |
| **Objective: To explain working of Random Access Turing Machine (TM) as a model of computation and Universal Turing Machine (UTM)** | | | | W11 |
| L51 | Random Access Turing Machine Definition and Examples | L | 2 |
| L52 | Random Access Turing Machine Examples | L | 2 |
| L53 | Turing Machine as a model of computation | L | 2 |
| L54 | Universal Turing Machine (UTM) | L | 2 |
| L55 | Problems based on UTM | L | 2 |
| **Objective: To discuss the problem of decidability of languages/input and Halting problem** | | | | W12 |
| L56 | Language acceptability | L | 2 |
| L57 | Language acceptability (Continued) | L | 2 |
| L58 | Decidability | L | 2 |
| L59 | Halting problem | L | 2 |
| L60 | Problems solving | L | 2 |
| **Objective: Revision and Discussion** | | | | W13 |
| L61 | Revision of Unit I | L | 1 |
| L62 | Revision of Unit II | L | 1 |
| L63 | Revision of Unit III | L | 1 |
| L64 | Problems solving | T |  |
| L65 | Problems solving | T |  |
| **Objective: Revision and Discussion** | | | | W14 |
| L66 | Revision of Unit IV | L | 1 |
| L67 | Revision of Unit V | L | 1 |
| L68 | Revision of Unit VI | L | 2 |
| L69 | Problems solving | T |  |
| L70 | Problems solving | T |  |

**Teacher name: Dr. Shweta Tyagi**

**Sign:**