# COURSE INFORMATION SHEET

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| **Session:** | Spring-2025 |
| **Course Title:** | Theory of Automata & Formal Languages |
| **Course Code:** | CS-224 |
| **Credit Hours:** | 3 |
| **Semester:** | 4th |
| **Pre-Requisites:** | None |
| **Instructor Name:** | Dr. Abdul Hameed Pitafi / Dr. Syed Muhammad Atif |
| **Email and Contact Information:** | [muhammad.atif@ssuet.edu.pk](mailto:muhammad.atif@ssuet.edu.pk) / [hameedpitafi@hotmail.com](mailto:hameedpitafi@hotmail.com) |
| **WhatsApp Group** |  |
| **Office Hours:** | *01:30am To 05:30pm (Every Thursdays and Friday)* |
| **Mode of Teaching:** | Synchronous/Asynchronous/ Hybrid/Blended |

**COURSE OBJECTIVE:**

This course aims to understand the basic theory of computation concepts that lie at the backbone of all state-of-the-art applications and program design.

Students should understand the capabilities and limits of computation, particular applications and capabilities of deterministic and non-deterministic finite automata, context-free grammars, and finally Turing machines.

**COURSE OUTLINE:**

Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene’s theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees, and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context-sensitive languages, grammars and linear bounded automata (LBA), Chomsky’s hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs.

**COURSE LEARNING OUTCOMES (CLOs) and its mapping with Program Learning Outcomes (PLOs):**

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| **CLO**  **#** | **Course Learning Outcomes (CLOs)** | **P\_L\_O** | **Bloom’s Taxonomy** |
| 1 | **Explain** the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, context free grammar, Turing machines etc. | PLO\_1  (Academic Education) | C2 (Understanding) |
| 2 | **Design** Finite Automata (FA), Regular Expression (RE), Push Down Automata (PDA), Context-Free Grammar (CFG), Chomsky Normal Forms (CNF) and Derivation Trees. | PLO\_2 (Knowledge for Computing Problem) | C3 (Apply) |
| 3 | **Transform** between equivalent NFAs, DFAs and REs and between equivalent CFGs, PDA and CNFs | PLO\_3 (Problem Analysis) | C4  (Analysis) |

**RELATIONSHIP BETWEEN ASSESSMENT TOOLS AND CLOs:**

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| **Assessment Tools** | **CLO-1** | **CLO-2** | **CLO-3** | **Total** |
| **Quizzes** | 3 (11.54%) | 3 (8.33%) | 4(10.53%) | 3 (11.54%) |
| **Assignments** | 3 (11.54%) | 3 (8.33%) | 4 (10.53%) | 3 (11.54%) |
| **Midterm Exam** | 10 (38.46%) | 10 (27.78%) | 10 (26.31%) | 10 (38.46%) |
| **Final Exam** | 10 (38.46%) | 20 (55.56%) | 20 (52.63%) | 10 (38.46%) |
| **Total** | 26 (26%) | 36 (36%) | 38 (52.63%) | 26 (26%) |

**GRADING POLICY:**

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| **Assessment Tools** | **Percentage** |
| Quizzes | 10% |
| Assignments | 10% |
| Midterm Exam | 30% |
| Final Exam | 50% |
| TOTAL | 100% |

## Text Book:

* Introduction to computer theory, Daniel I. A. Cohen, 2nd Edition, by John Wiley & Sons, 2017.

## Reference Books:

* Automata, computability and complexity: theory and applications, Elaine Rich, 1st Edition, by Upper Saddle River: Pearson Prentice Hall.
* Automata, Computability and Complexity: Theory and Applications, by Elaine Rich, 2011
* An Introduction to Formal Languages and Automata, by Peter Linz, 4th edition, Jones & Bartlett Publishers, 2006
* Theory of Automata, Formal Languages and Computation, by S. P. Eugene, Kavier, 2005, New Age Publishers.

**LECTURE PLAN**

**Course Title: Theory of Automata & Formal Languages**

**Course Code:** CS-224T

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| **Week #** | | **Date** | | **Course plan** | **Recommended Reading** | **Assessment Tools** |
| Week 1 | | 06-03-2025  to  07-03-2025 | | Introduction to Finite Automata and Its importance in the field of Computer Science. | Dcoh, Ch-1  Page#9 |  |
| Week 2 | | 10-03-2025  to  14-03-2025 | | Types of Automata  Intro To Finite State Mechanism  Deterministic Finite Automata  Representations of Automata | Dcoh, Chap-5  Page#63  Erich, Ch-5  Page# 54  Dcoh, Ch-4  Page# 38  Page# 40 |  |
| Week 3 | | 17-03-2025  to  21-03-2025 | | Introduction To NFA and ϵ-NFA  Conversion from ϵ-NFA to NFA and NFA to DFA. | Dcoh, Ch-5  Page # 70,71  Dcoh, Ch-8  Page # 143 | Assignment #1 |
| Week 4 | | 24-03-2025  to  28-03-2025 | | Decision Properties of Regular Languages  Union, Intersection, Difference, Concatenation, Kleene Closure, Reversal, Homomorphism, Inverse Homomorphism | Dcoh, Ch-8  Page # 146, 147, 148 | Quiz #1 |
| Week 5 | | 31-03-2025  to  04-04-2025 | | DFA Minimization  Equivalence State Minimization Algorithm | Erich, Ch-5  Page# 65-69 |  |
| Week 6 | | 07-04-2025  to  11-04-2025 | | DFA Minimization  Mayhill Nerode Minimization Algorithm (Table Filling Method) | Erich, Ch-5  Page# 65-69 |  |
| Week 7 | | 14-04-2025  to  18-04-2025 | | Introduction To Regular Expressions  Equivalence from Regular Expressions to Finite Automata | Dcoh, Ch-6  Page# 86  Dcoh, ch- 7  Page # 101  Page # 111 |  |
| Week 8 | | 21-04-2025  to  25-04-2025 | | Pumping Lemma for Regular Languages |  |  |
| Week 9 | | **Midterm Examination**  **(28-04-2025 to 03-05-2025)** | | | | |

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| **Week #** | | **Date** | | **Course plan** | **Recommended Reading** | | **Assessment Tools** | |
| Week 10 | | 05-05-2025 to  09-05-2025 | | Mealy Machines, Moore Machines.  \Conversion from Moore to Mealy  Conversion from Mealy to Moore | Dcoh, Ch-9    Page # 155-163 | | Assignment #2 | |
| Week 11 | | 12-05-2025 to  16-05-2025 | | Introduction To Non-Regular Languages  Introduction To Context-Free Grammar | Erich, Ch-8  Page# 169  Erich, Ch-11  Page# 203 | |  | |
| Week 12 | | 27-05-2024 to  31-05-2024 | Derivation and Derivation Trees  Ambiguity in Derivation Trees | | Erich, Ch-11  Page# 218,219  Erich, Ch-11  Page# 220 | | Quiz #2 | |
| Week 13 | | 03-06-2024 to  07-06-2024 | Context-free Languages  Normal Form and Parsing | | Erich, Ch – 13  Page # 279  Page # 327,340 | |  | |
| Week 14 | | 10-06-2024 to  14-06-2024 | Decidability  Context-sensitive Languages  Chomsky Hierarchy | | Dcoh, Ch-23  Page # 526  Erich, Ch-24  Page # 526,539 | |  | |
| Week 15 | | 17-06-2024 to  21-06-2024 | Chomsky Normal Form with examples  Introduction To Push Down Automata (PDA) | | Dcoh, Ch- 16  Page # 301  Dcoh, Ch-17  Page # 333 | |  | |
| Week 16 | | 24-06-2024 to  28-06-2024 | PDA Problems and Solutions  PDA and CFG | | Dcoh, Ch-18  Page # 340  Dcoh, Ch-18  Page # 370 | | Quiz #3 | |
| Week 17 | | 01-07-2024 to  05-07-2024 | Introduction To the Turing Machine  Controlling Non-regular Languages | | Dcoh, Ch-24  Page # 551  Erich, Ch-8  Page# 170 | | Assignment  #3 | |
| **FINAL EXAMINATION**  **(08-07-2025 to 19-07-2025)** | | | | | | | | |

Dcoh = Daniel I. A. Cohen, Erich = Elaine Rich

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| **Teacher’s Name**  **and Signature:** | Dr. Syed Muhammad Atif | **Date:** | **\_1**0-03-2025**\_\_\_\_\_\_** |
| **Assoc. Chairperson’s Name and Signature:** | Dr. Abdul Hameed Patafi | **Date:** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |