FAST National University of Computer and Emerging Sciences,
Peshawar Campus
(Department of Computing Science)

LECTURE PLAN / COURSE OUTLINES

Course Title : ***THEORY OF AUTOMATA***
Instructor : Shakir Ullah Shah
Course Code : CS301
Credit Hours : Three (3)
Semester: Fall 2020
Pre-requisite : Discrete Structures

Introduction

The automata theory concerned with models (automata) used to simulate objects and processes such as computers and digital circuits. This theory helps engineers to design and analyze digital circuits which are parts of computers, telephone systems, or control systems. It uses ideas and methods of discrete mathematics to determine the limits of computational power for existing and for future computers.

Automata theory is closely related to formal language theory as the automata are often classified by the class of formal languages they are able to recognize. Automata play a major role in compiler design and parsing. It deals with designing of new Computer Language. It includes grammar & its type, Finite State Automata [FSA], Regular Expression [RE], Transition Graph [TG and Turing Machine.

Course Objectives

1. To introduce the basic parts of formal languages
2. To describe the various methods to define a language
3. To teach different formal models of computation such as Finite Automata and Turing Machines
4. To build mathematical models and then to study their limitations
5. To understand about the various types of Languages, including Regular languages
6. learn how to model computation mathematically, and pick up some useful formalisms & techniques

Course Outcomes

The students will get the following outcomes upon completion of this course:

1. Language and its basic parts
2. Finding the language, successful inputs of a machine
3. How to define languages
4. Language processing machines, including FSA , TG , Mealy & Moore machines
5. Comparison of various Languages

Course Policy:

Attendance: At least 80% attendance is required by each student. Students failing to have the required attendance would not be allowed to appear in the final exam, resulting in 'F' grade in the course. No relaxation shall be given in this regard. It must be clear that only those would be marked present which are physically present during major part of the class. Any student, who comes after the attendance has been taken, may be marked late and a student who misses major part of a class may be marked absent.

Late Homework: Deadlines for all assignments are firm and no changes would be made once they are announced. All the assignments must be submitted (both in hard form as well as through e-mail) before the start of class on the submission day. Late assignments may be accepted at a penalty of minimum 15% deduction of marks if it is submitted within 24 hours of the deadline. After that no relaxation should be expected.

Quizzes: Short quizzes would be conducted during the class to keep a check on your understandings and to keep you paced up with the daily tasks. These quizzes will be announced but surprise quizzes are also possible. Quizzes would be taken at the start of the class so anybody who comes late may miss that. There is no retake of a missed quiz in any condition.

Marks Contest Deadlines: The marks contest deadlines for all instruments is 3 days after marks are announced. NO changes will be entertained after that.

Plagiarism: is not acceptable and no excuse would be listened. You should be very careful regarding that. Study "Little Book about Plagiarism" published by HEC. You should keep you deliverables secret and should NOT place them in any public location (e.g. temp folder) to avoid such problem. Any plagiarized material may result in ZERO for all Quizzes or Assignments or Project. Severe punishment may cause an "F" in the course so be careful.

Tool:

JFLAP - software for experimenting with formal languages topics including nondeterministic finite automata, nondeterministic pushdown automata, several types of grammars, parsing, and L-systems.

Homepage: www.jflap.org

Evaluation Criteria :

Assignments	10 %
Quizzes	10 %
Mid-Term	30 %
Final	40 %
Class Participation	10%

Tentative Weekly Plan

Week #	Topics
1	**Background:** Strings, Graphs and Trees, Inductive Proofs, Set Notations, Relations
2	**Introduction:** Introduction to Theory of Automata, Formal and In-formal languages, Alphabets, Strings, Defining languages, Descriptive definition of languages with examples

3	**Languages:** Kleene Closure, Languages, Operations on Languages, Properties and Theorems, Recursive definition of languages with examples, Homomorphism of Languages, Binary Relation
4	**Regular Expressions:** Regular Expressions, Constituent parts of Regular Expression, Language associated with Regular expression, Rules for language association with R.E's
5	**Finite Automata:** Finite State Automata (FSA/DFA/FA), Transition Table, Construction of DFA accepting a RE, FSA types i.e. Deterministic & Non-Deterministic Finite Automata (NDFA/NFA), Applications of Finite Automata
6	**Transition Graph (TG):** Transition Graph, Constitution Parts of TG, Difference b/w TG and FSA, TG's for various constructs of languages, Generalized Transition Graphs (GTG)
7	**Kleene Theorem:** Kleene Theorem, Application of Kleene theorem, Parts of Kleene theorem, Statement of each Part and its application , Relation among FSA , TG , Regular Expression
8	**Proof of Kleene theorem:** Proof of Part-I of Kleene theorem, Conversion of FSA to Regular Expression & TG's, Proof of Part-II of Kleene theorem, Conversion of Regular Expression to FSA , TG's, Proof of Part-III of Kleene theorem Conversion of TG's to Regular Expression , FSA
9	**Finite Automata with Output:** Finite Automata with Output, introduction, Mealy Machine , Moore Machine and their applications, Conversion of Mealy-to-Moore, Conversion of Moore-to-Mealy machine
10	**Context Free Grammar:** Ir-regular Languages and its various examples, Context Free Grammar, Parts of CFG, Terminal Symbols , Non-Terminal Symbols, Examples of CFG, Unit productions, Ambiguous CFG
11	**Chomsky Normal Form:** Chomsky Normal Forms, Chomsky Grammar, Recursion, Types of Recursion [Left , Right], Elimination of Left Recursion theorem,
12	**Push down Automata:** Push down Automata (PDA), parts of PDA, types of PDA i.e. Deterministic Push down Automate and non-deterministic Push Down Automata, New format for FSA used in PDA, PDA Stack, Examples of various PDAs
13	**Turing Machines:** Turing Machines (TM) and its parts, Turing Machines and its application, Examples of various Turing Machines, variations on the TM, Universal TM

14	**Post Machine:** Introduction, Definition of Post Machine (PM), PM Model, simulating a PM on a TM,
15	**The Chomsky Hierarchy:** Regular Grammars, Unrestricted Grammars, Context Sensitive Languages, Relation between classes of languages, Universal Turing Machine

Recommended Books:

1. Text: Introduction to Computer Theory (2nd Edition : Automata Theory) by Danial I.A. Cohen

2. Ref: Introduction to the Theory of Computation, Michael Sipser, 2nd edition, Thomson Course Technology, 2005.