Ex/CSE/T/314A/2017

. Bachelor of Computer Science & Engineering Examination 2017

(3RD YEAR 1ST SEM)

FORMAL LANGUAGE & AUTOMATA THEORY

Time: Three hours

Answer any ***five*** questions Full Marks: 100

1. Construct Deterministic Finite Automatas to accept the following languages with necessary justifications :

   (a) All binary strings of length ≤ 3 and all binary strings where every substring of length 4 contains at least three 1's.

   (b) All binary strings where the *absolute* difference between the number of 0's and 1's in *every* prefix is *at most* 1.

2. (a) State and prove the Pumping Lemma for regular languages. Why it is useful? 12+8

   (b) Prove that for each positive integer n, there exists a language L_n over $\{a, b\}$ such that L_n can be accepted by a NDFA with $n+1$ states but any DFA accepting L_n must have at least 2^n states.

3. (a) Explain the concept of ϵ-closure of a set of states of a NDFA. 10+10

   (b) Prove that for each non-deterministic finite automata, there exists an *equivalent* deterministic automata.

4. (a) Develop regular expressions for all strings of $\{a, b\}$ that contain an *even* number of a's and *odd* number of b's. 3+17

   (b) Prove that the language accepted by a DFA can always be described by a regular expression.

5. (a) Construct a Push Down Automata to accept the language $\{a^i b^j c^k : i = j \text{ or } j = k,\ i, j, k \geq 0\}$ with necessary justifications. 8+12

   What is the mode of acceptance of your PDA?

   Explain all sources of non-determinism present in the transitions of this PDA.

   (b) Prove that if a language L is accepted by a NDFA, then the language L^* can also be accepted by a NDFA.

6. (a) Explain when is a Push Down Automata called *deterministic*. 10+10

   Prove that languages accepted by DPDA's with empty stack are *prefix-free* languages.

   (b) Prove that a language is accepted by a PDA with empty stack *if and only if* it is accepted by a PDA with final states.

7. (a) Find out the language generated by the grammar whose production rules are : 6+14

   (i) $S \rightarrow aSbS$, (ii) $S \rightarrow bSaS$, (iii) $S \rightarrow \epsilon$

   Give necessary justifications.

   (b) Develop a grammar for the language $\{a^i b^j c^k d^l : i + j = k + l,\quad i, j, k, l \geq 0\}$ with necessary proof.

12+8