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Thapar University, Patiala

Department of Computer Science and Engineering

END SEMESTER EXAMINATION

B. E. (Third Year): Semester-I (2018/19) (COE)

Course Code: UCS701

Course Name: Theory of Computation

December 10 , 2018

Time: 3 Hours, M. Marks: 100 Weightage: 46

Name Of Faculty: AKU, NK, NS, RA

Note: ***Attempt all questions with proper justification. Assume missing data, if any, suitably.***

Q.1(a) Design a **minimized** deterministic finite automaton and regular expression for the language over $\Sigma = \{0, 1\}$, such that (5)

i) Starts with 0 and having odd length Or

ii) Starts with 1 and having even length

Q1(b) Given $\Sigma = \{a, b\}$, $L_1 = \{a, ab\}$ and $L_2 = \{b, a, ba\}$. Perform following operation on L_1 and L_2.

i) $L_1 - L_2$ (1)

ii) Complement of L_1 and L_2 (2)

iii) All strings up to 3 length of L_1^*. (2)

Q2(a) Convert the following Moore machine M_0 into Mealy machine. (4)

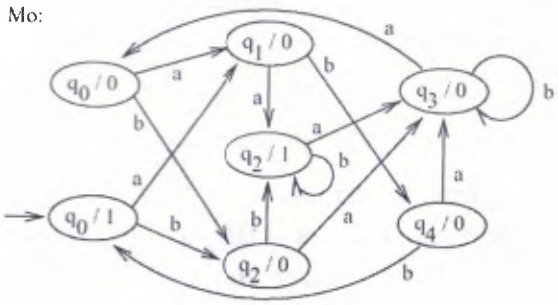

Fig. 1: Moore machine M_0

Q2(b) Prove using mathematical induction that every language of the form 0^{mx+b}, where m and b are positive integer constants and x ranges from 0 to infinite is regular language. (6)

Q3(a) Minimize the following DFA M_1: (5)

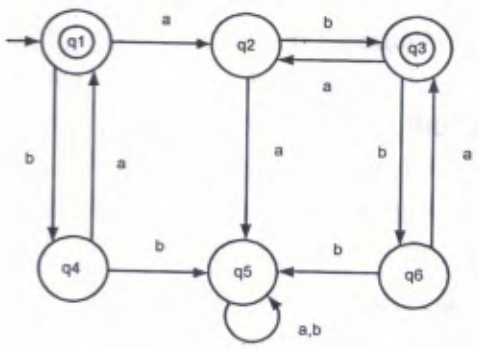

Fig. 2: DFA M_1

Q3(b) Show that the language $L_3 = \{a^n b^n c^n \mid n > 0\}$ is accepted by a 2-PDA. You may assume that there is a # symbol at the end of the string and a $ symbol at the beginning to mark the end points. (5)

Q4(a) Design Pushdown automata for the language $L_4 = \{10^n1^n \cup 110^n1^{2n} \mid n > 0\}$ (6)

Q4(b) Check whether the following grammar is ambiguous or not. Justify your answer. (4)

$$S \rightarrow iCtS \mid iCtSeS \mid a \qquad C \rightarrow a$$

Q5(a) For each of the languages below, indicate the smallest complexity class that contains it (i.e. Type-3, Type 2, Type 1 or Type 0). For instance, If a language satisfies all Type 0 to Type 3 mention answer as Type 3. **Justify your answer,** not need to prove your answers. (5)

i. $0^n1^m0^p1^q$ where n+m = p+q, and n, m, p, q > 0
ii. $0^n1^m0^m1^n$ where n, m > 0
iii. $0^n1^m0^p1^q$ where n, m, p, q > 0.
iv. 0^m over the alphabet {0}, where m is of the form 2k + 1, k > 0
v. $0^m10^{m!}$ where m > 0

Q5(b) Give any one application of context-free grammar and explain in detail how context-free grammar is used in the mentioned application. (5)

Q6 Generate Context-free grammar and derive a string for each languages:

i) $L_7(G) =$ Set of odd length string whose first, middle and last symbol is same over $\Sigma = \{a, b\}$. (3)

ii) $L_8(G) = \{a^n b^m \mid 0 \le n < m \le 2n\}$ (3)

iii) $L_9(G) = \{(ab)^n (cb^m)^n \mid n \ge 0, m > 0\}$ (4)

Q7 Given the following grammar (10)

S → AB | BC, A → BA | 0
B → CC | 1, C → AB | 0

Apply CYK algorithm to check whether $w = 000000$ belongs to this language or not?

Q8(a) Explain the concept of Post correspondence problem with the help of an example. (6)

Q8(b) What do you mean by recursive and recursive enumerable languages? Give example of both. What is relation between them? (4)

Q9(a) Convert given Context Free Grammar into Chomsky Normal Form (4)

$S \rightarrow AB \mid a \qquad A \rightarrow BC \mid b \qquad B \rightarrow aB \mid C \qquad C \rightarrow aC \mid B$

Q9(b) Explain the difference between non-deterministic pushdown automata and deterministic pushdown automata with the help of examples. (6)

Q10 Design a Turing machine (using single R/W head) for the language $L_{10} = \{ww \mid w \in \{0,1\}^*\}$ over $\Sigma = \{0, 1\}$. Explain your logic and give instantaneous description for the string $w = 101101$. (10)

**********End of Paper**********