Motilal Nehru National Institute of Technology Allahabad

Department of Computer Science & Engineering

End Semester Examination

May 2018

Subject- Automata Theory (CS 1404), B. Tech (CS) - 4th Semester

Duration- 3 hours **Max. Marks: 60**

Attempt all questions. Assume if something missing.

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1. (a) Consider the following two DFAs M and M' over $\{c, d\}$ given in fig. 1. Determine whether M (q_1 as a final state) and M' (q_4 as a final state) are equivalent? (3)

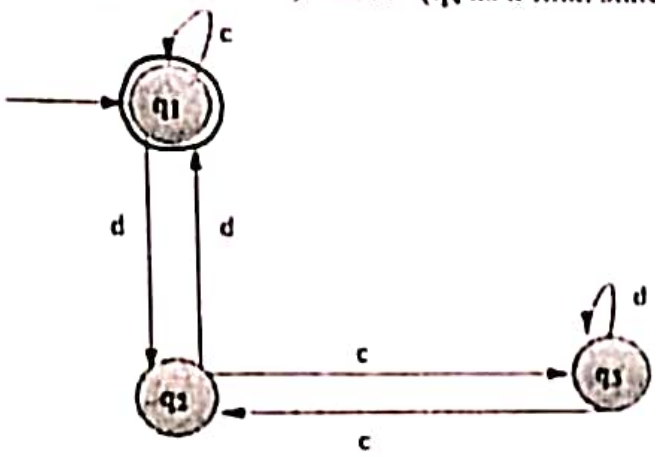

Fig. 1 (a): M

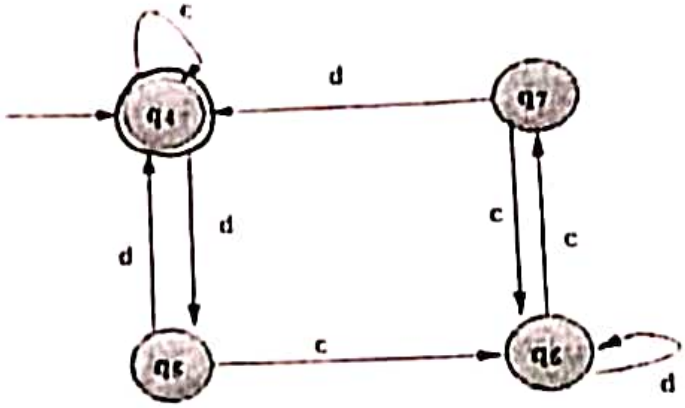

Fig. 1 (b): M'

(b) Using the pumping lemma theorem, show that the following sets are not regular: (3)

i. $L = \{(ab)^n a^k : n > k,\ k \geq 0\}$

ii. $L = \{ww : w \in \{a, b\}^*\}$

2. (a) Construct the regular grammar accepting the following language: (3)

$L = \{w \in \{a, b\}^* \mid w \text{ is a string over } \{a, b\} \text{ such that the number of } b\text{'s is } 3 \bmod 4\}$

(b) Let $G = (V, T, S, P)$ be a right-linear grammar. Prove that the language generated using the grammar G is a regular. (3)

3. Eliminate useless, Λ-production and unit productions from the given grammar: (6)

$$S \rightarrow a/aA/B/C$$
$$A \rightarrow aB/\Lambda$$
$$B \rightarrow Aa$$
$$C \rightarrow cCD$$
$$D \rightarrow ddd$$

4. Find context-free grammars for the following languages: (6)

(a) $L = \{a^n b^m : n \leq m + 3,\ n \geq 0, m \geq 0\}$

(b) $L = \{a^n b^m : n \neq m,\ n \geq 0, m \geq 0\}$

(c) $L = \{ww^R : w \in \{a, b\}^*\}$

5. (a) Find the regular expression corresponding to fig.2 using Arden's theorem. (q_4 as a final state) (3)

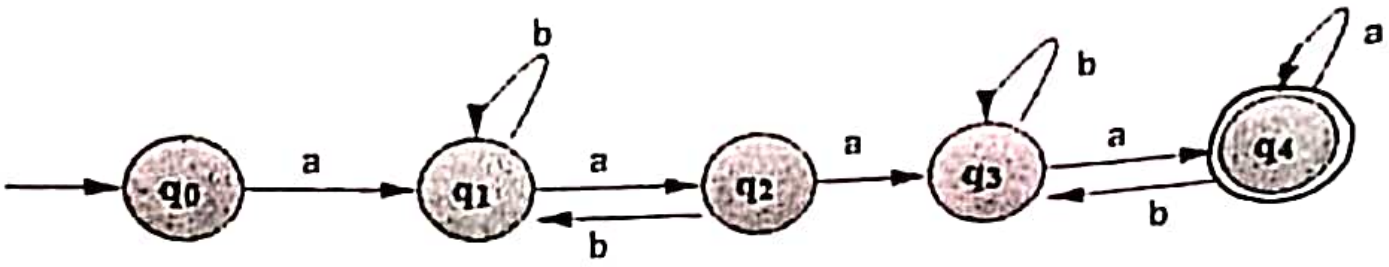

Fig. 2

(b) Find the grammar in Chomsky Normal Form (CNF) equivalent to production given as: (3)

$$S \rightarrow aAbB$$
$$A \rightarrow aA/a$$
$$B \rightarrow bB/b$$

6. Construct an Non-Deterministic Push Down Automata (NPDA) corresponding to the grammar: (6)

$$S \rightarrow aABB/aAA$$
$$A \rightarrow aBB/a$$
$$B \rightarrow bBB/A$$

7. Construct a Non-Deterministic Push Down Automata (NPDA) accepting by final state each of the following languages: (6)
   (a) $L = \{a^n b^m c^n \mid m, n \geq 1\}$
   (b) $L = \{ww^R : w \in \{a, b\}^+\}$
   (c) $L = \{a^{3n} b^n : n \geq 1\}$

8. Construct Turing machines that will accept the following languages on $\{a, b\}$: (6)
   (a) $L = \{w: n_a(w) = n_b(w)\}$
   (b) $L = \{wcw : w \in \{a, b\}^+\}$

9. Find the Linear bounded automata for the following languages: (6)
   (a) $L = \{a^n b^n : n \geq 1\}$
   (b) $L = \{ww: w \in \{a, b\}^+\}$

10. Use CYK algorithm to determine whether the string $w = aabbb$ is in the language generated by the grammar: (6)

$$S \rightarrow AB$$
$$A \rightarrow BB/a$$
$$B \rightarrow AB/b$$