

Theory of Automata (CS3005) Sessional-I Exam

Date: February 25th 2025

Course Instructor(s)

Syed Faisal Ali, Ms. Shaharbano, Ms. Bakhtawar, Ms.
Zain Noreen, Ms. Abeeha Sattar

Total Time (Hrs): 1

Total Marks: 15

Total Questions: 4

Roll No

Section

Student Signature

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Attempt all the questions.

1. Do not waste pages by adding extra sheets.
2. Draw proper readable diagrams to get marks.
3. Solve the paper according to the question order.

CLO #1: Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions

Question1: Short Answer Questions.

[Marks: 02]

- a. Define an NFA and a DFA. Can an NFA accept the same language as a DFA? Explain your answer
- b. Explain the concept of NFA-epsilon and describe how epsilon-closure is used to solve it.
- c. What steps would you take to eliminate states in a transition graph, and why is this process important?
- d. Compare and contrast the role of regular expressions and finite automata in automata theory.

Solution

a. NFA (Non-deterministic Finite Automaton): An automaton where for each state and input symbol, there may be multiple possible next states, including the possibility of no transition at all.
DFA (Deterministic Finite Automaton): An automaton where for each state and input symbol, there is exactly one transition to a next state. Yes, an NFA can accept the same language as a DFA. Although NFAs can have multiple possible transitions for a given state and input, they can be converted into an equivalent DFA that accepts the same language.

- b. NFA-epsilon is an NFA that allows transitions without consuming any input symbol (i.e., epsilon transitions, denoted as ϵ). Epsilon-closure is the set of all states reachable from a given state through epsilon transitions alone. It's used to handle transitions where no input symbol is consumed, ensuring that all possible states are considered during the NFA simulation.
- c. To eliminate states in a transition graph, one would: Identify and remove unreachable states (states not reachable from the initial state).

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Remove dead states (states that do not lead to an accepting state). Combine equivalent states (states that behave identically for all input sequences). This process simplifies the automaton, improving efficiency and making it easier to analyze.

- d. Regular Expressions (RE): Provide a formal way to describe patterns in strings and are a high-level abstraction for describing regular languages. Finite Automata (FA): Are concrete computational models that recognize regular languages by moving through states based on input symbols. While both describe regular languages, regular expressions are more abstract and compact, while finite automata are a more explicit computational model used for recognition or simulation of those patterns.

CLO # 4: Transform between equivalent NFAs, DFAs and REs

Question 2. A geographical team comprises of Ahmed, Bilal, Chandio and Dilawar. They were on the expedition of some mineral testing sites when their island has been hit by a tornado. They have tried to reach the temporary cabin for their research work which was destroyed. The only message they got is to reach the bridge way and get on boat which is waiting for them. The boat will leave in 30 minutes. They have received the message five minutes ago so they have 25 minutes to reach on boat. The distance from their cabin to bridge is 8 minutes. After 8 minutes they come to rickety old wooden bridge. The bridge is weak and only able to carry the weight of two of them at a time. Because they are in a rush and the light is fading they must cross in the minimum time possible and must carry a torch (flashlight) on each crossing. They only have one torch and it can't be thrown. Because of their different fitness levels and some minor injuries, they can all cross at different speeds. Ahmed can cross in 1 minute, Bilal in 2 minutes, Chandio in 5 minutes and Dilawar in 10 minutes. You must select the maximum time of a partner to cross the bridge. Your task is to design a Finite Automata to solve this strategy and mentioned what will be the minimum time require to reach on boat safely? **[Marks: 04]**

Solution

Total Time Calculation:

First crossing: 2 minutes (Ahmed and Bilal).

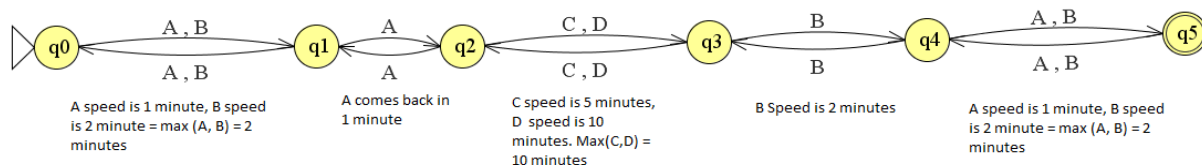
Return crossing: 1 minute (Ahmed).

Second crossing: 10 minutes (Chandio and Dilawar).

Return crossing: 2 minutes (Bilal).

Final crossing: 2 minutes (Ahmed and Bilal).

Total time = 2 + 1 + 10 + 2 + 2 = 17 minutes.



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CLO # 3: Design of automata, Regular Expression

Question 3: You have been hired as a compiler developer for a new programming language. Your task is to build a lexical analyzer that detects C-style comments in source code. A valid C-style comment must:

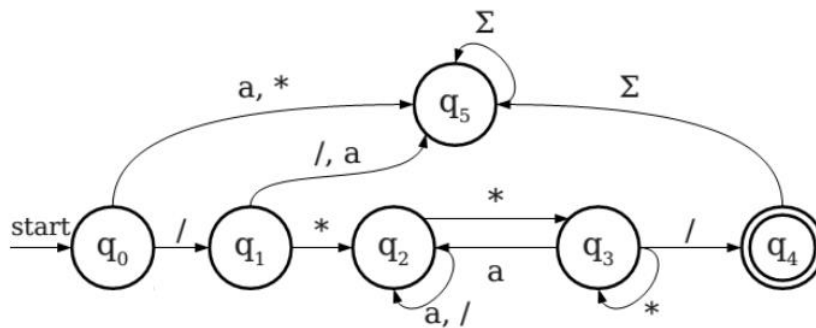
[Marks: 02]

1. Start with /* (a forward slash followed by an asterisk).
2. Contain any sequence of characters (a, *, /) inside.
3. End with */ (an asterisk followed by a forward slash).
4. Reject anything that does not start with /* or does not end properly.

Your DFA must validate whether a given input is a correctly formatted C-style comment, where $\Sigma=\{a,*,/\}$

Some Accepted Strings	Some Rejected Strings
/*a*/ /**/ ****/ /*aaa*aaa*/	/** **/a aaa/**/ */

Solution



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CLO # 3: Design of automata, Regular Expression

Question 4.a Find 3 accepted and 3 rejected strings of $|w| > 3$ and $|w| < 6$. You are supposed to convert the NFA into DFA. **[Marks: 04]**

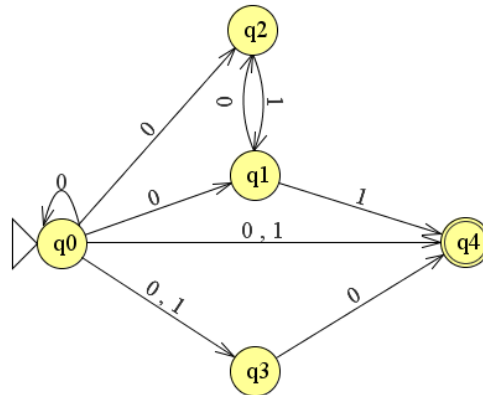


Figure 1: NFA

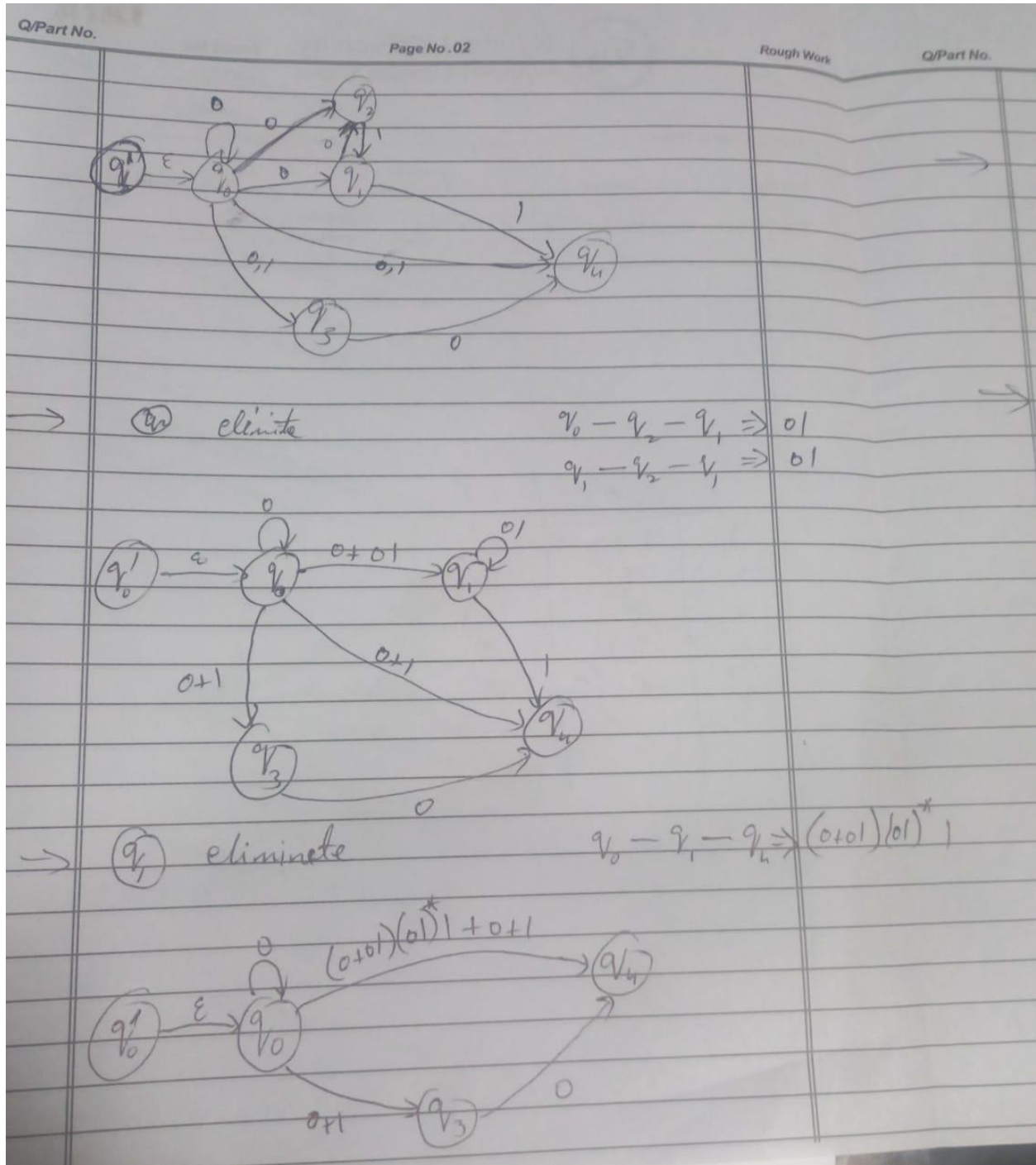
Solution:

NFA to DFA Table

states	0	1
q0	q0,q1,q2,q3,q4	q4,q5
q0,q1, q2, q3, q4	q0,q1, q2, q3, q4	q1,q3,q4
q3,q4	q4	φ
q1,q3,q4	q2,q4	q4
φ	φ	φ
q2,q4	φ	q1
q1	q2	q4
q2	φ	q1

Question 4: b. Derive the regular expression of the NFA as shown in figure 1. Show proper steps to secure full marks. **[Marks: 03]**

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\Rightarrow q_3 $q_0 = q_3 = q_u \Rightarrow (0+1)(0)$
 $q_0 \xrightarrow{0} q_0 \xrightarrow{(0+01)(01)^*1+0+1+(0+1)0} q_u$
 \Rightarrow q_0 $q_0 \rightarrow q_u \Rightarrow R.E$
 $q_0 \xrightarrow{0^*[(0+01)(01)^*1+0+1+(0+1)0]} q_u$

$$= \sim * \sim = * = \sim * \sim = * = \sim * \sim = * = \sim * \sim = * = \sim * \sim =$$