CS340 - 2023 Quiz 1

DIVYANSH

TOTAL POINTS

16 / 20

QUESTION 1

1 Question 1 4 / 4

✓ **+ 4 pts** *correct DFA and correct explanation*

** 3 states, a correct indication of final/non-final/dead states*

** Understanding of DFA of A and DFA of M*

** mentioning switching of states*

** examples, if required*

QUESTION 2

2 Question 2 2 / 6

✓ **- 4 pts** *Constructed correct NFA*

QUESTION 3

3 Question 3 6 / 6

✓ **- 0 pts** *Correct*

Improper Explanation

QUESTION 4

Question 4 4 pts

4.1 subpart (a) 2 / 2

✓ **+ 1 pts** *Yes/No provided*

✓ **+ 1 pts** *Explanation provided*

4.2 subpart (b) 2 / 2

✓ **+ 1 pts** *yes/no provided*

✓ **+ 1 pts** *explanation provided*

CS340 (2023) – Quiz 1

Duration: 35 minutes, Total marks: 20, Pages: 6.

- **Important note.** Answers without clear and concise explanations will not be graded.

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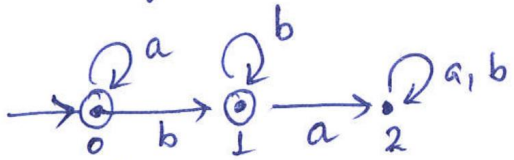
Problems

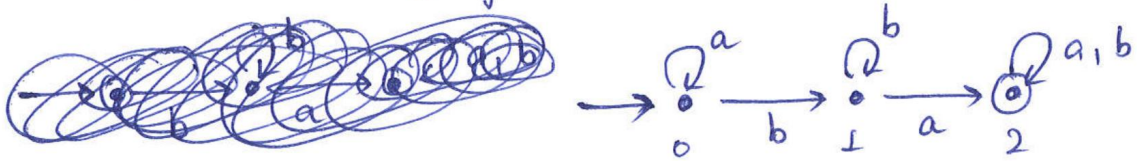
1. **(4 marks)** Let $\Sigma = \{a, b\}$ and let $A = \{a^n b^m \mid n \geq 0, m \geq 0\}$. Construct a DFA M with at most 3 states such that $L(M) = \bar{A}$ (complement of A). Give a brief and precise justification for your answer.

I will first construct DFA for A,



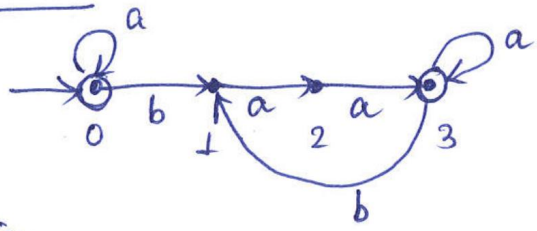
explanation :- we want to make sure that the string has first all 'a's (if any) and all b's (if any). So if the string has any 'a's after the 1st 'b' it will move to state '2' and will not be accepted.

(b) DFA for $\bar{A}$ (changing the final states)



2. **(6 marks)** Let $\Sigma = \{a, b\}$ and let $A = \{x \in \Sigma^* \mid$ every b is immediately followed by at least two $a\}$. For example, $abaaa \in A$, $abaabaa \in A$, $abbaa \notin A$ and $abbaaaa \notin A$. Construct a DFA M with at most 5 states such that $L(M) = A$. Give a brief and precise justification for your answer.

Automata:-



Description

So there are 4 states to the automata,

Case-I: the string doesn't have any 'b' so the state will remain '0' and hence accepted.

Case-II: string has 'b', so it will move to state '1' and inorder to get accepted it will need to 2 'a' to reach state '3'.

Further, encountering another 'b', state will change back to '1' and we are again at Case-II.

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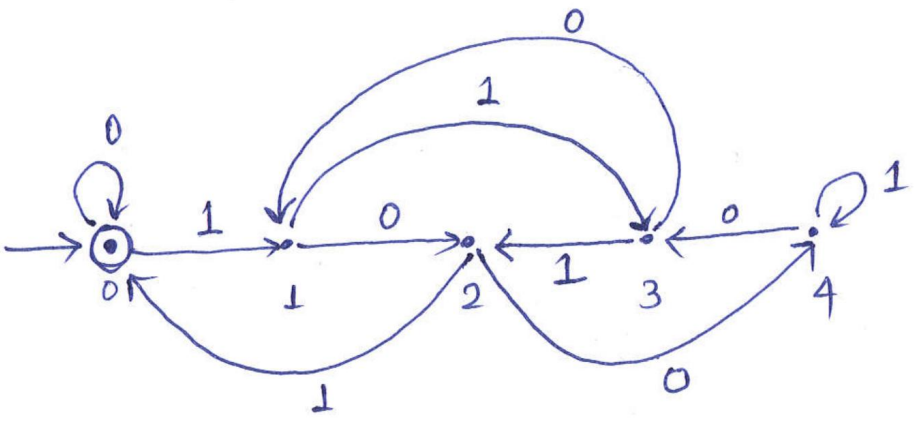
3. **(6 marks)** Let $\Sigma = \{0, 1\}$ and let $A = \{x \in \Sigma^* \mid x \text{ represents a multiple of five in binary}\}$. Note that leading zeros are permitted and ϵ represents the number 0. Construct a DFA M with at most 5 states such that $L(M) = A$. Give a brief and precise justification for your answer.

constructing 5 states corresponding $\#x \bmod 5 = 0, 1, 2, 3, 4$ where $\#x$ denotes the decimal number denoted by binary string x.



Explanation from binary number theory we can say

$(\#x\,0) \bmod 5 = (2(\#x) + 0) \bmod 5$

$(\#x\,1) \bmod 5 = (2(\#x) + 1) \bmod 5$

So changing the state (modular) based on the next bit in the input string.

4. **(4 marks)** Consider the automaton N_1 given in Figure 1 and N_2 given in the Figure 2.

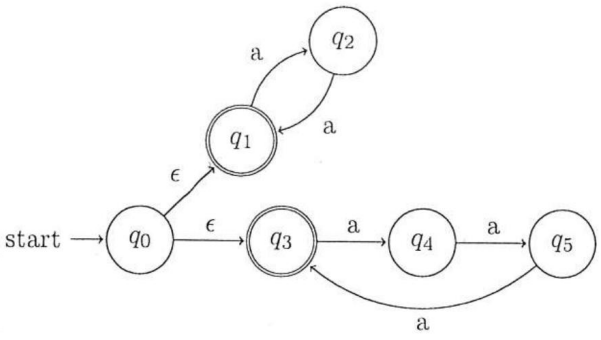


Figure 1: N_1

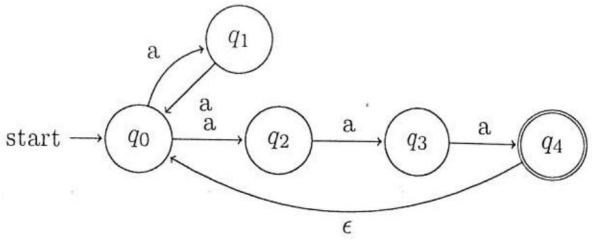


Figure 2: N_2

Answer the following with precise explanations.

(a) Is $L(N_1) - L(N_2) = \emptyset$?

$L(N_1) := \{ x \mid x = a^n$ such that n is divisible by 2 or 3 $\}$

$L(N_2) := \{ x \mid x = a^n$ such that it is of form $n = 3m + 2k$ $\}$
$m > 0,\ k \geq 0$

clearly $L(N_1)$ and $L(N_2)$ satisfy for divisibility by 3 but not for 2

(b) Is $L(N_2) - L(N_1) = \emptyset$?

Hence, $L(N_1) - L(N_2) \neq \phi$

Similarly as in the above part

$L(N_2) - L(N_1) \neq \phi$

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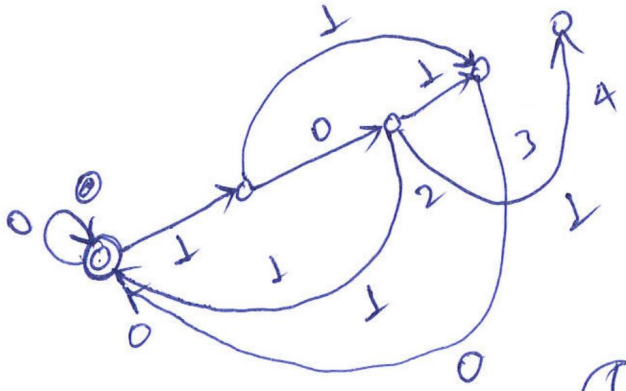
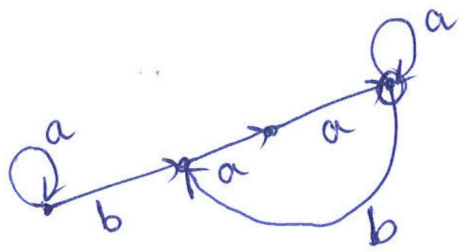


#x00 → 0
#x01 → 1
#x10 → 2
#x11 → 3



$3x + 2k$