MIDTERM EXAMINATION

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Winter 2023 – CLOSED Book Exam –Total marks: 20 – Duration: 60 mins

This exam comes in **four** pages.

NAME_____ID_____Group_____

Question 1 [3 marks] **Obtain the regular expressions for the following sets:**

(a) The set of all strings over {a, b} beginning and ending with 'a'.

a (a + b) * a

(b) {b^2, b^5, b^8, … }

bb(bbb)*

(c) {a^{2n+1} | n>0 }

aaa(aa)* OR a(aa)*

Question 2 [4 marks]

For each of the following languages, give two strings that are members and two strings that are *not* members—a total of four strings for each part. Assume the alphabet ∑ = {a,b} in all parts.

a. a(ba)*b

b. $a^* \cup b^*$

c. $\sum^* a \sum^* b \sum^* a \sum^*$

d. (a ∪ ba ∪ bb) $\sum^*$

Answer: Any string matched each part.

Question 3 [3 marks]

Define the language that can be defined using the alphabet ∑ = {0, 1} and can be represented using the following regular expressions

a. $\sum^* 1 \sum^*$

b. $(\sum \sum \sum)^*$

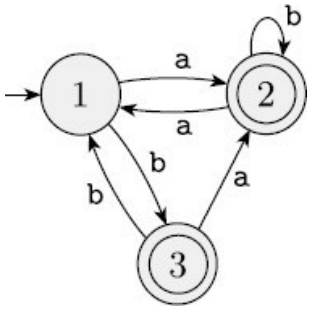
c. $1^*(01^+)^*$

Answer

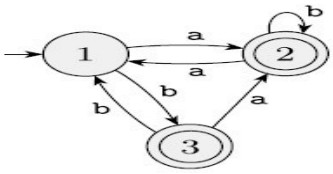
$$\Sigma^*1\Sigma^* = \{w|\ w \text{ has at least one } 1\}.$$
$$(\Sigma\Sigma\Sigma)^* = \{w|\ \text{the length of } w \text{ is a multiple of } 3\}.$$
$$1^*(01^+)^* = \{w|\ \text{every } 0 \text{ in } w \text{ is followed by at least one } 1\}.$$

Question 4 [6 marks]

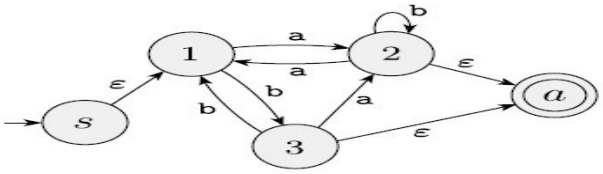
a. Convert the following FA into regular expressions. [2 marks]



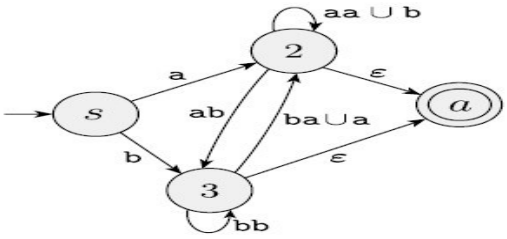
Answer :



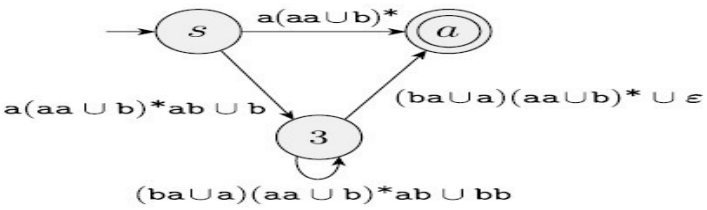
(a)



(b)



(c)



(d)

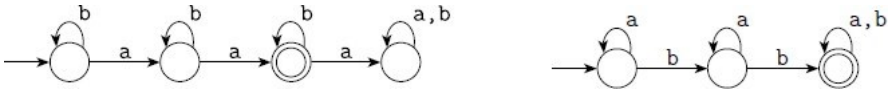
(a(aa∪b)*ab∪b)((ba∪a)(aa∪b)*ab∪bb)*((ba∪a)(aa∪b)* ∪ε)∪a(aa∪b)*

b. Construct a DFA for the following languages [4 marks]

i. {w|w has exactly two a's}

ii. **{w|w has at least two b's}**

Answer



Formal Definition

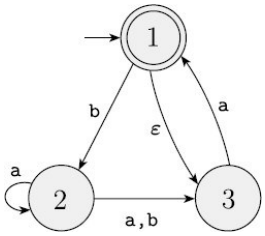
M1 = {{q0, q1,q2,q3}, {a,b}, T1, q0, {q2})
M2 = {{q0, q1,q2}, {a,b}, T2, q0, {q2})

OR can define each item in a separate row

T1	A	B
q0	q1	q0
q1	q2	q1
q2	q3	q2
q3	q3	q3

T2	A	b
q0	q0	q1
q1	q1	q2
q2	q2	q2

Question 5 [4 marks] **Given the following NFA *N* construct the equivalent DFA *D. You must illustrate all the steps in clear way.***



Answer:

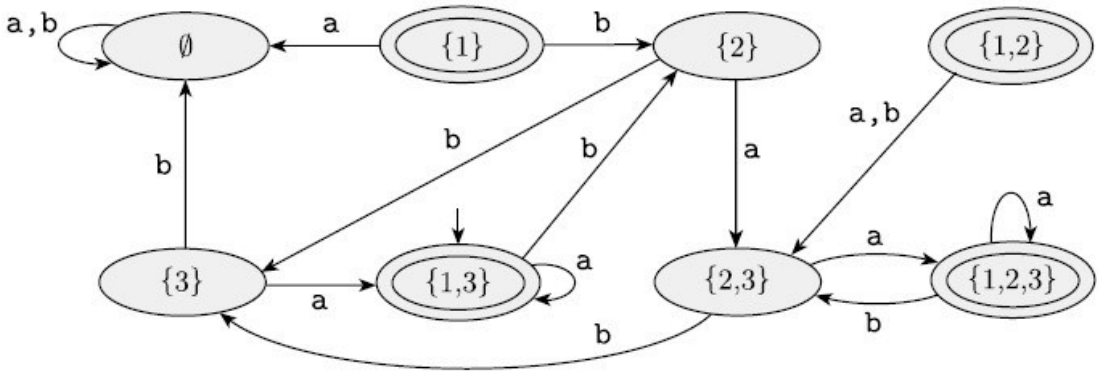


FIGURE 1.43
A DFA D that is equivalent to the NFA N_4

We may simplify this machine by observing that no arrows point at states $\{1\}$ and $\{1, 2\}$, so they may be removed without affecting the performance of the machine. Doing so yields the following figure.

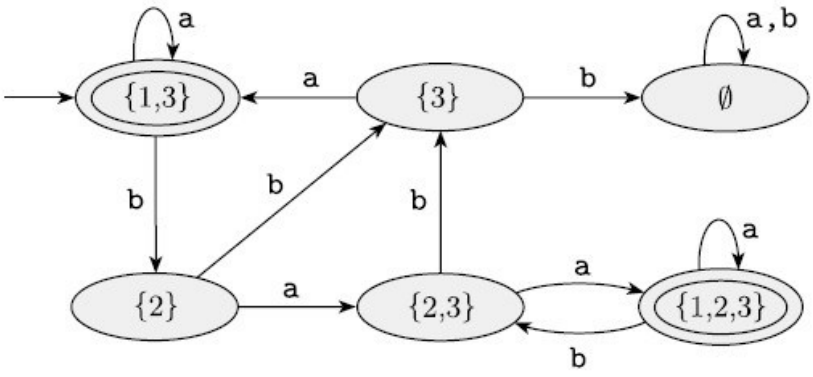


FIGURE 1.44
DFA D after removing unnecessary states

End of exam