CS & IT ENGINEERING

Theory of Computation

DFA

Lecture No.- 04

By- Venkat sir

Recap of Previous Lecture

Topic — DFA Design

Topic — possibility of DFA.

if Dependency exist → DFA not possible

no Dependency → DFA possible

if DFA possible then that language is known as Regular Language.

if DFA not possible ⇒ Non Regular Language.

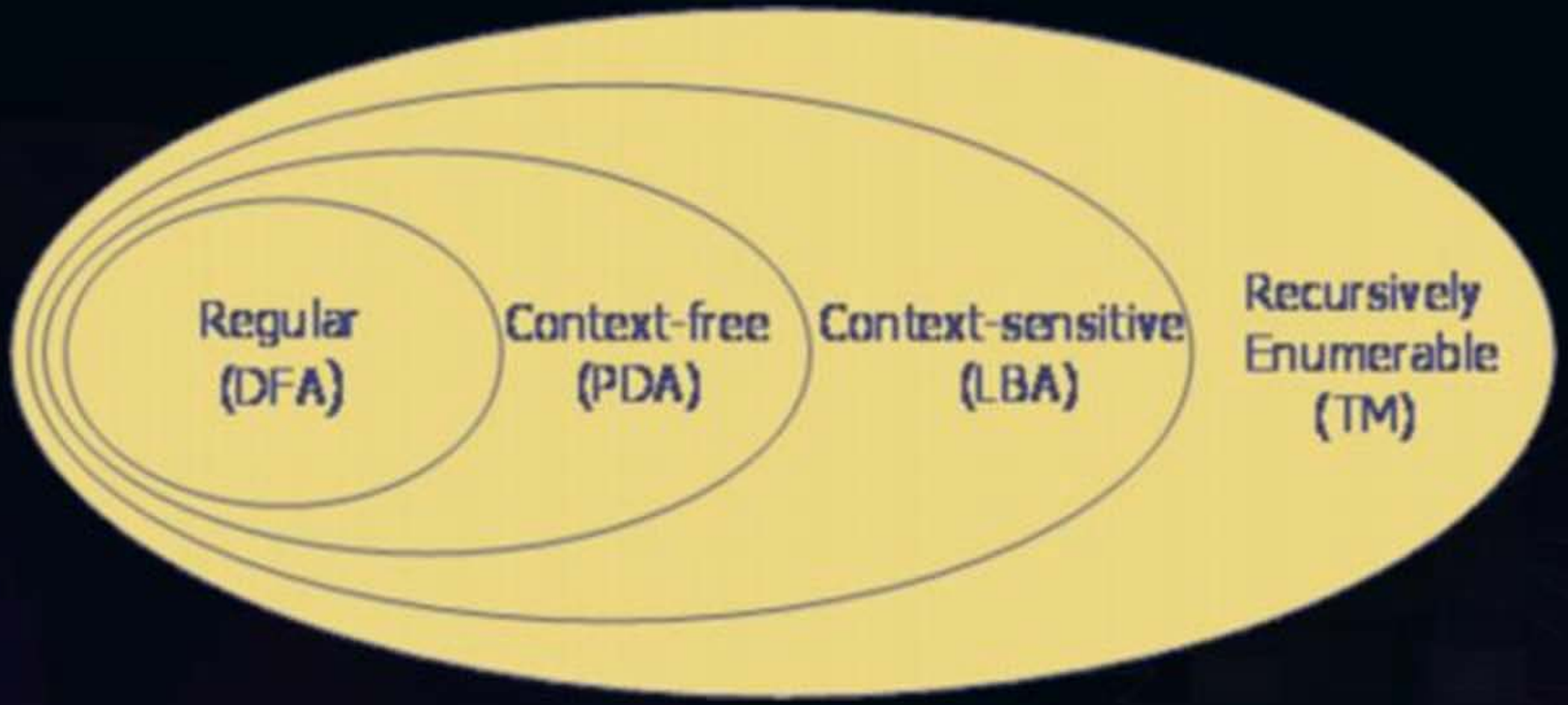
Topics to be Covered

- **Topic** Finite Automaton & Regular Languages.
- **Topic** Pushdown Automata & Context free Languages.
- **Topic** Turing Machine & Recursive Enumerable Languages.
- **Topic** Undecidability.

BOOKS:

1. PETER LINZ
2. MICHAEL SIPSER
3. HOPCROFT & ULLMAN

Topic : Theory of Computation



Topic : Finite Automata

It is a mathematical model which contains finite number of states and transitions.

Topic : Deterministic Finite Automata

DFA : It is a finite automata in which from every state on every input symbol exactly one transition should exits.

Topic : Deterministic Finite Automata

FORMAL DFA : DFA is defined as

$DFA = (Q, \sum, q_0, F, \delta)$

Q : Finite set of states

$\sum$: Input alphabet

q_0 : Initial state

F : Set of final states

δ : Transition function $Q * \sum \rightarrow Q$

DFA acceptance method:

1. **Start at the Initial State**: Begin at the initial state of the DFA.

2. **Read Input Symbols**: For each symbol in the input string, read it one by one.

3. **Follow Transitions**: Based on the current state and the input symbol being read, follow the transition defined by the transition function of the DFA. This transition function specifies the next state of the automaton for each combination of current state and input symbol.

4. **Repeat Until End of Input**: Continue this process of reading input symbols and following transitions until you reach the end of the input string.

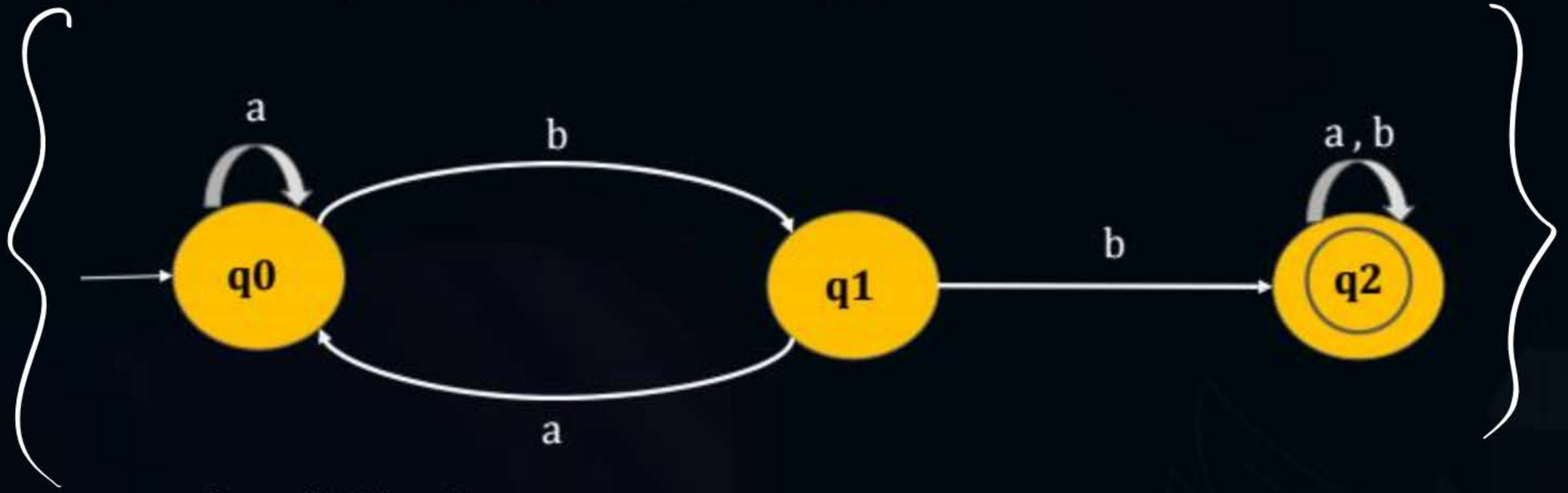
5. **Final State**: Once you have processed all input symbols, check the current state of the DFA. If it is one of the accepting states then the input string is accepted. Otherwise, it is rejected.

6. **Acceptance**: If the DFA halts in an accepting state after reading the entire input string, then the Input is accepted.

Sub string bb

bab

#Q. Identify language accepted by given DFA



Set of all strings

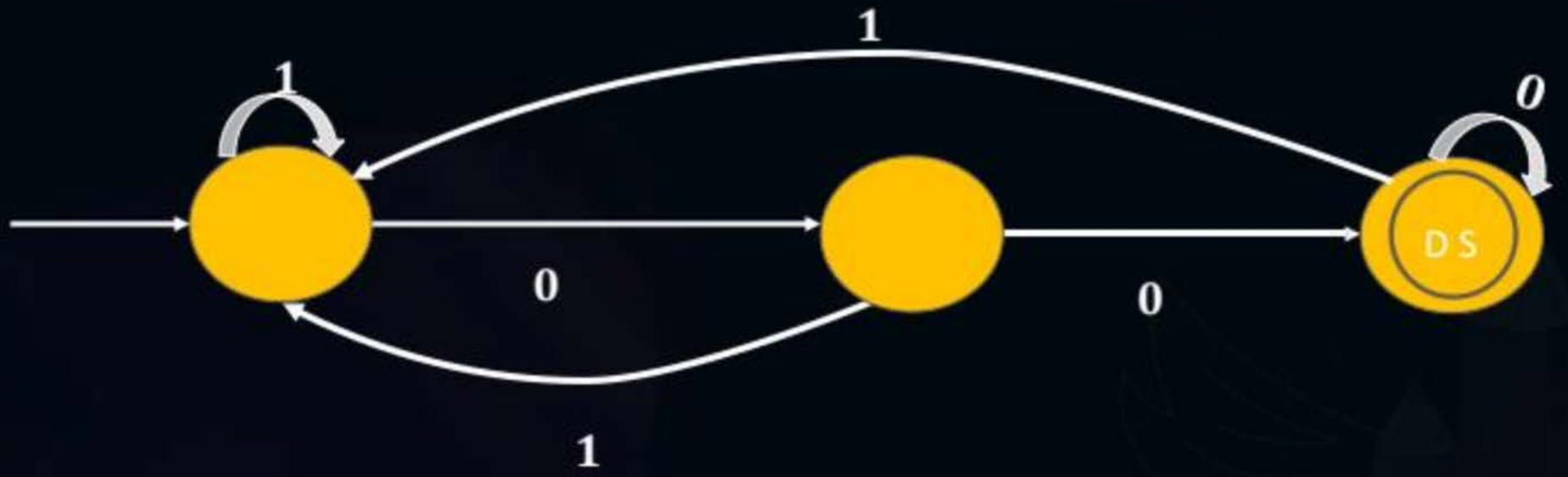
A Starting with bb

B Ending with bb

C Contains at least 2 b's

D None

#Q. Identify the language accepted by following DFA



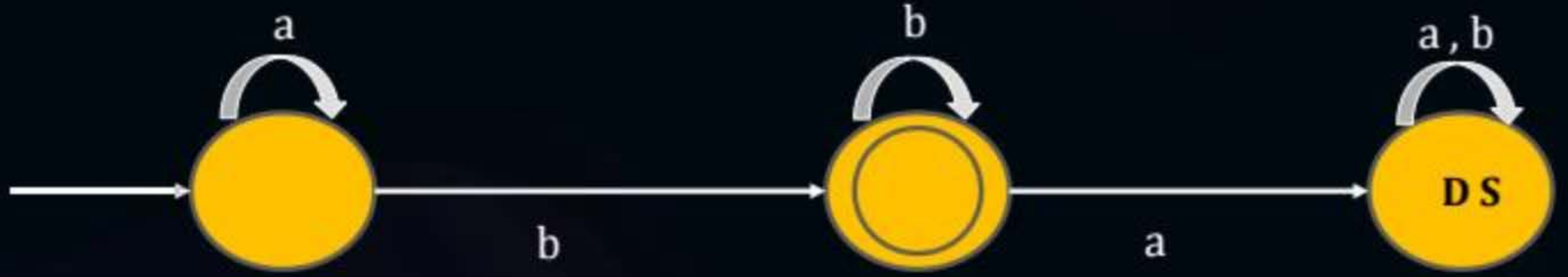
A Starting with 00

B Substring 00

C Ending with 0

D None

#Q. Identify language accepted by following DFA



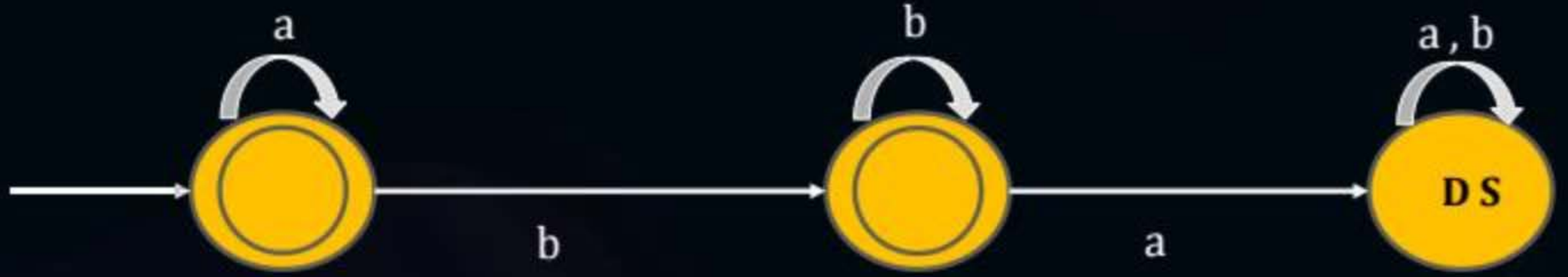
A $L = \{a^n b^m \mid n, m \geq 1\}$

B $L = \{a^n b^m \mid n \geq 1, m \geq 0\}$

C $L = \{a^n b^m \mid n, m \geq 0\}$

D None

#Q. Identify language accepted by following DFA



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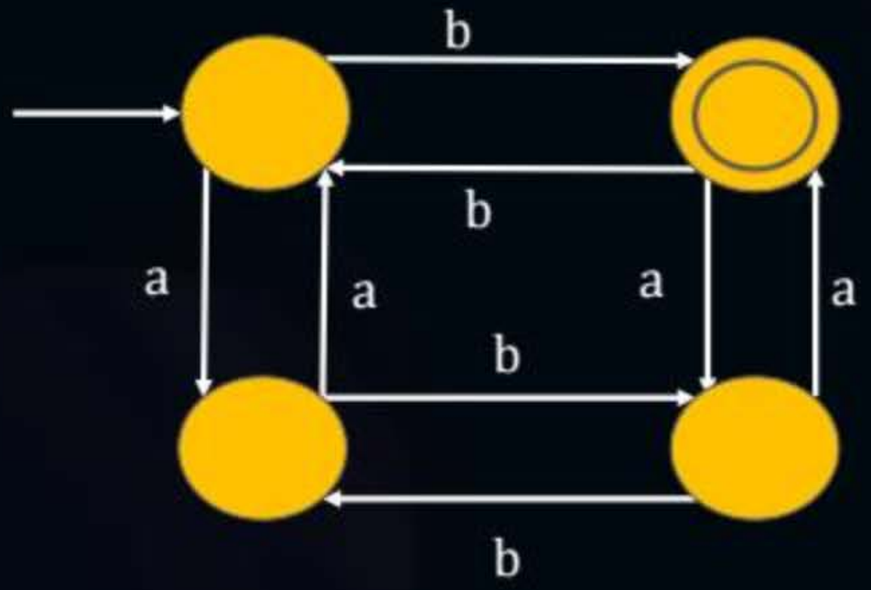
D None

#Q. Identify language accepted by following DFA



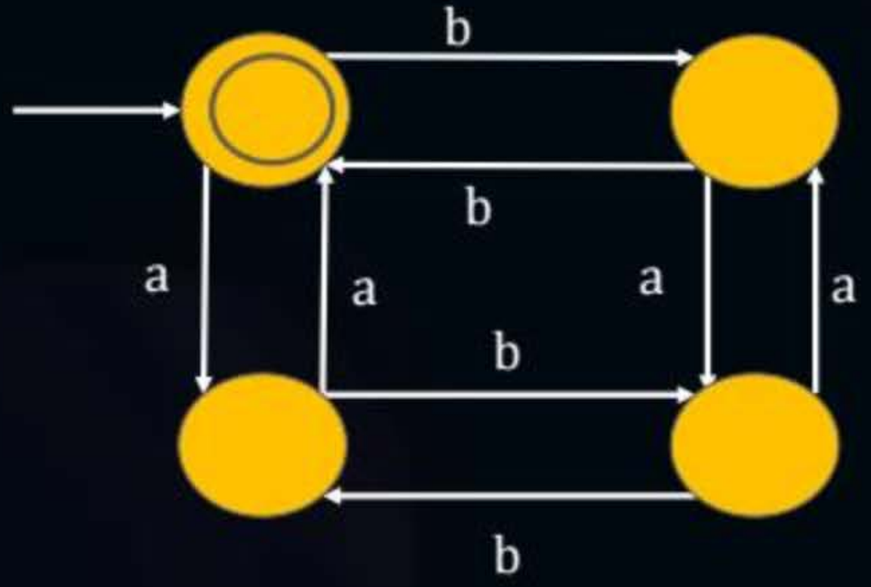
A # a's even and # b's even

B # a's odd and # b's even

C # a's odd and # b's odd

D # a's even and # b's odd

#Q. Identify language accepted by following DFA



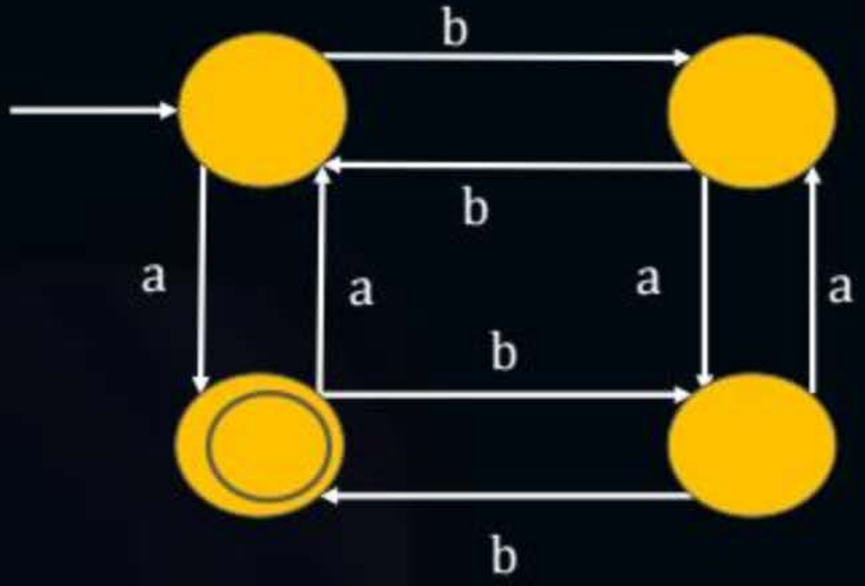
A # a's even and # b's even

B # a's odd and # b's even

C # a's odd and # b's odd

D # a's even and # b's odd

#Q. Identify language accepted by following DFA



A # a's even and # b's even

B # a's odd and # b's even

C # a's odd and # b's odd

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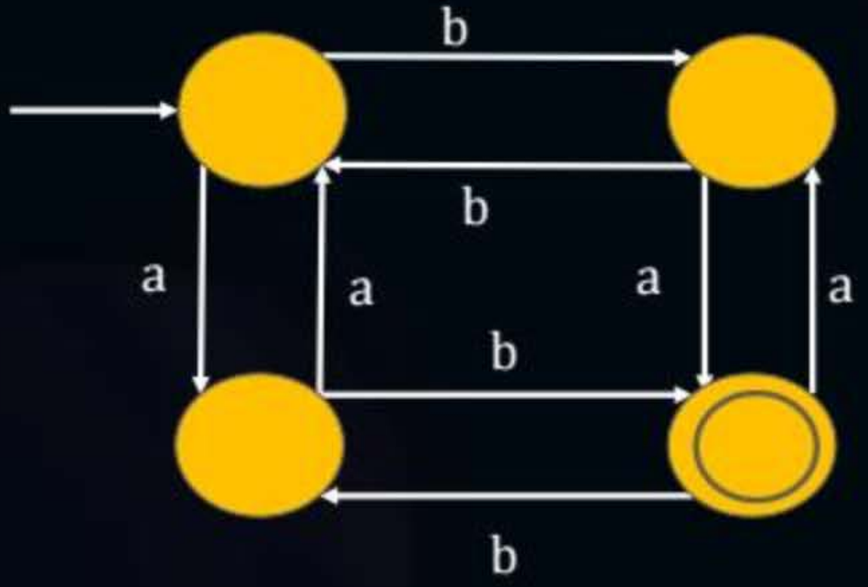


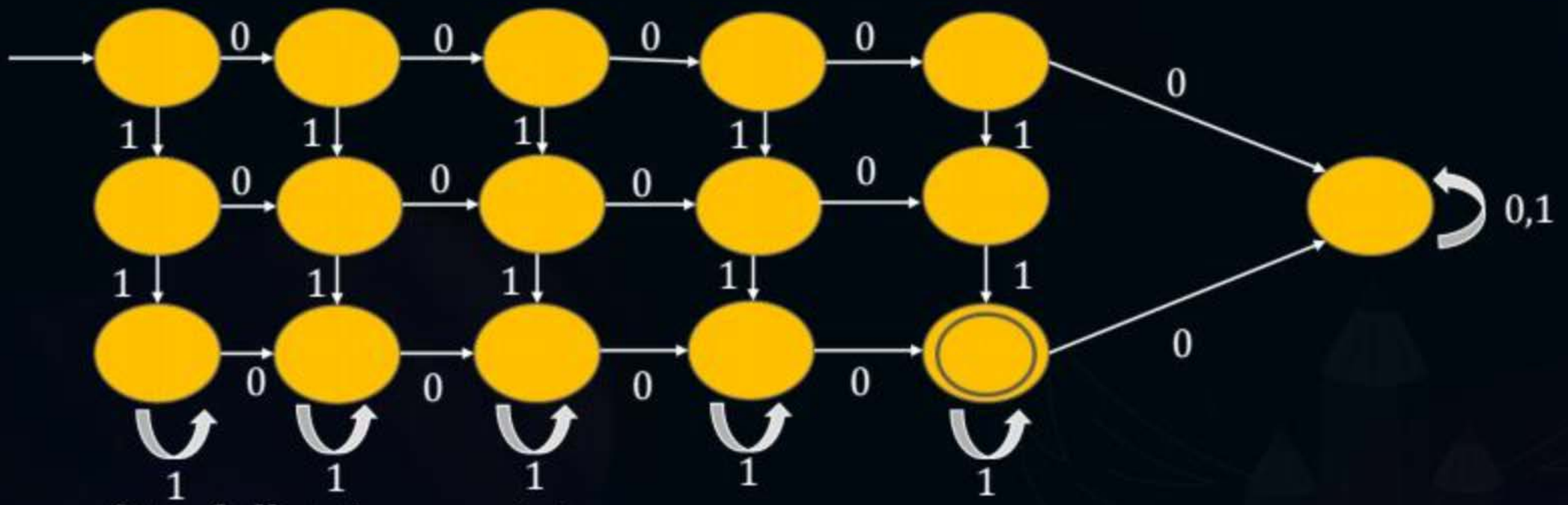
A # a's even and # b's even

B # a's odd and # b's even

C # a's odd and # b's odd

D # a's even and # b's odd

#Q. Identify language accepted by following DFA



Set of all strings contains

A Length of the string alteast 6

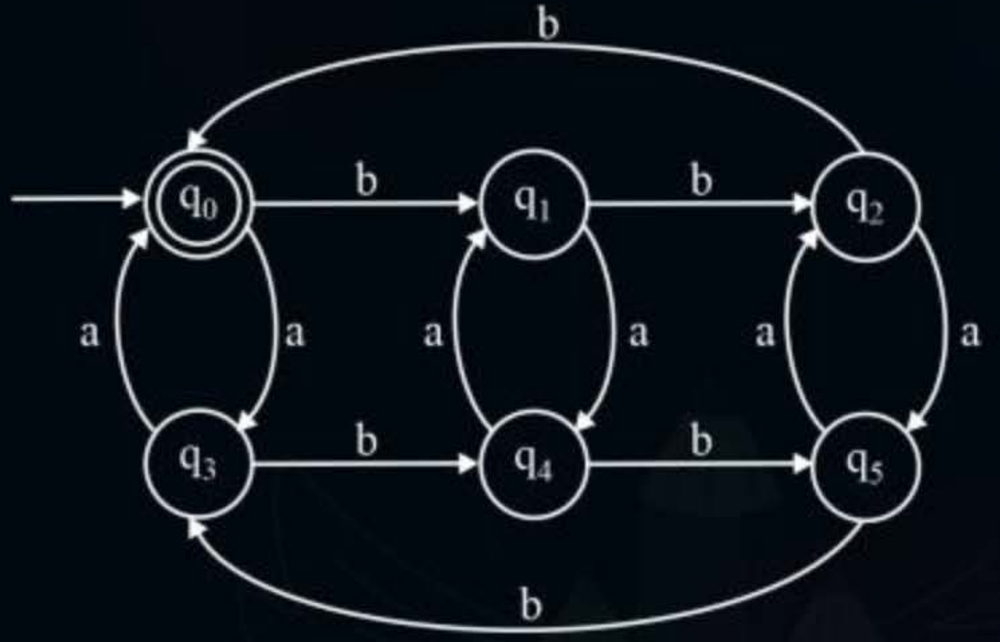
B # 0's exactly4 and 1's atleast 3

C # 0's atleast 4 and # 1's exactly 2

D None

MCQ

#Q. Consider the finite automaton m, m accepts all strings of a's and b's m which the number of a's and b's are respectively.



A Divisible by 3 and 2

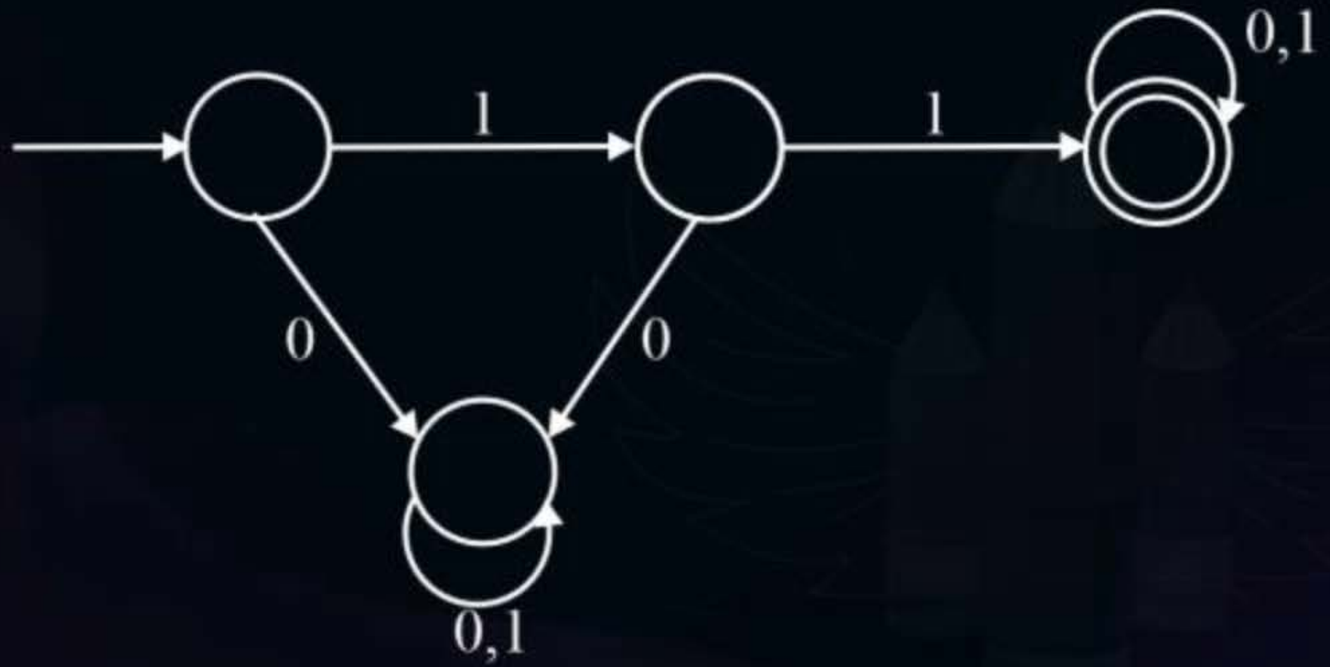
B Odd and even

C Even and odd

D Divisible by 2 and 3

MCQ

#Q. The number of binary strings of length n' accepted by the following finite automata is-



A $\{2^n | n \geq 0\}$

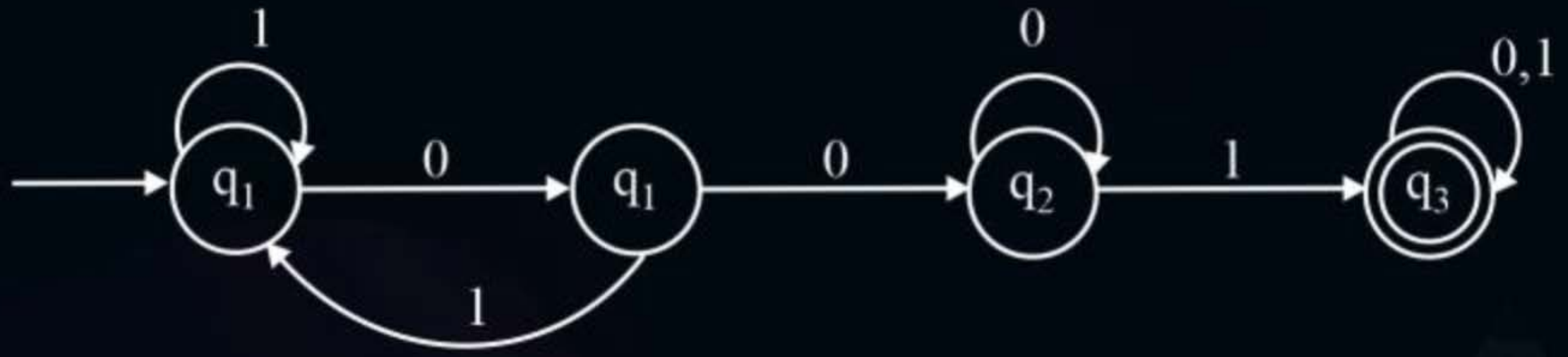
B $\{2^{n-1} | n \geq 1\}$

C $\{2^{n-2} | n \geq 2\}$

D $\{2^{n-3} | n \geq 3\}$

MCQ

#Q. Consider the following deterministic finite automata m.



The language accepted by finite automata, which is obtained by interchanging final and non-final states in m, is-

A The set of all strings containing 001 as the subtrings

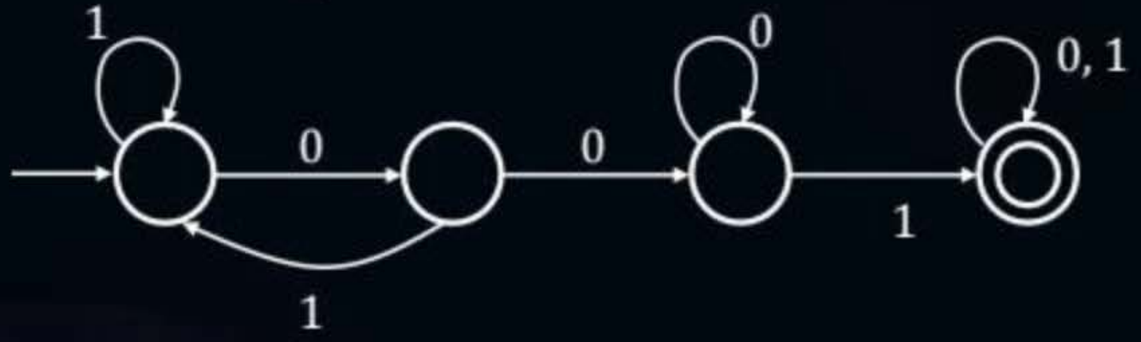
B The set of all strings not containing 001 as the subtrings

C The set of all strings ending with subtrings 001

D The set of all strings ending with subtrings 001

MCQ

#Q. Consider the following deterministic finite state automaton M.



Let S denote the set of seven-bit binary strings in which the first, the fourth, and the last bits are 1. The number of strings in S that are accepted by M is

A 1

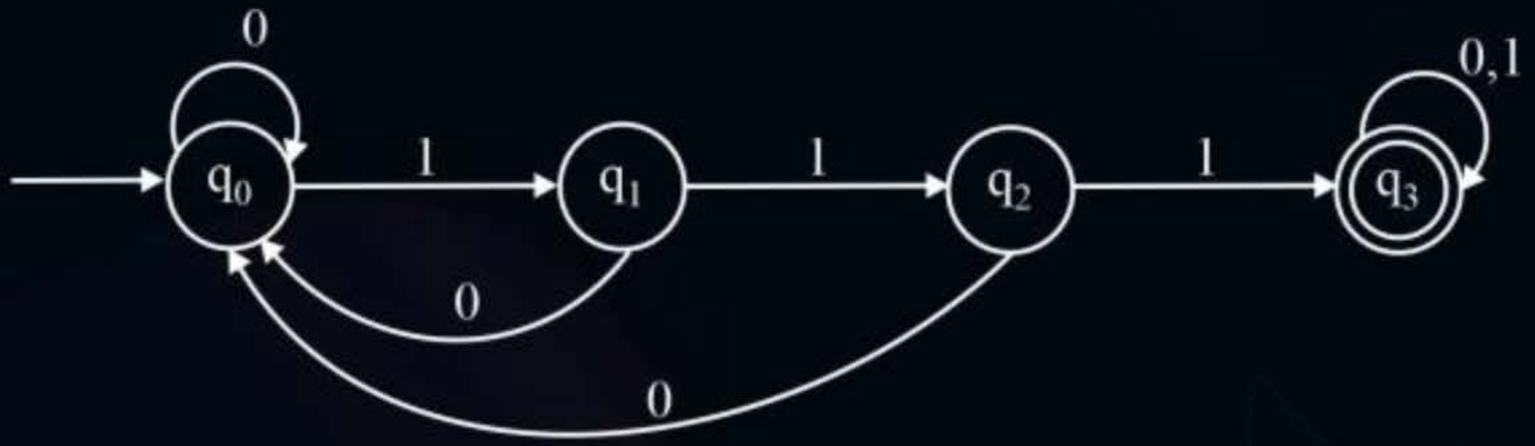
B 5

C 7

D 8

MCQ

#Q. Consider the finite automata m.



The language accepted by m is, over the alphabet {0,1}

A The set of all strings containing three consecutive I's

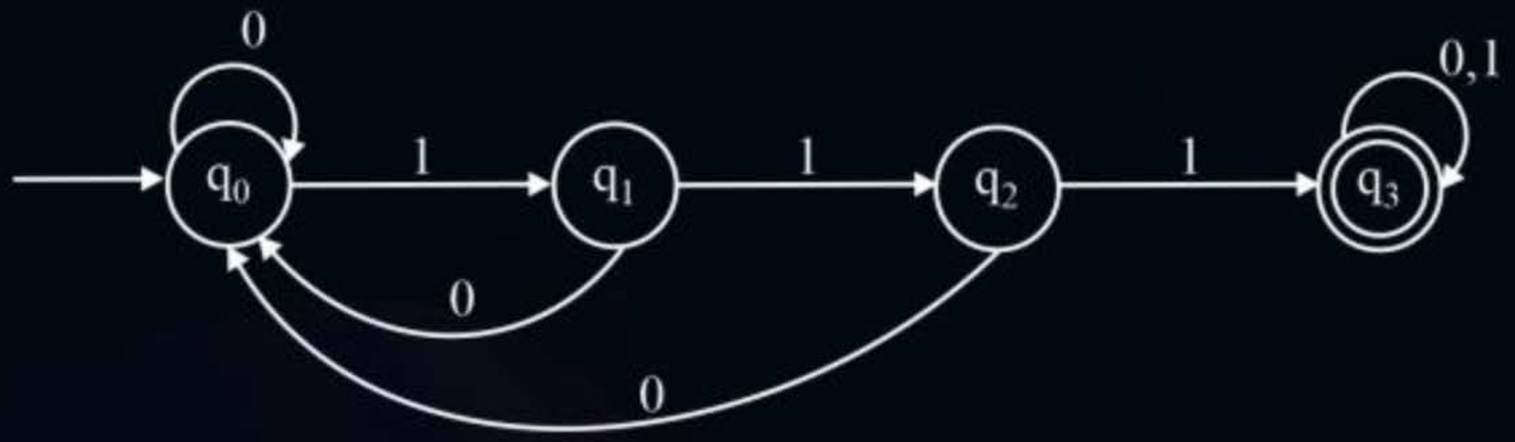
B The set of all strings not containing three consecutive I's

C The set of all strings beginnigs with three consecutive I's

D The set of all strings ending with three consecutive I's

MCQ

#Q. Consider the finite automata m.



Let S denotes the set of all six bit binary strings in which first and fourth bits are 1. The number of strings in S that are accepted by m is-

A 1

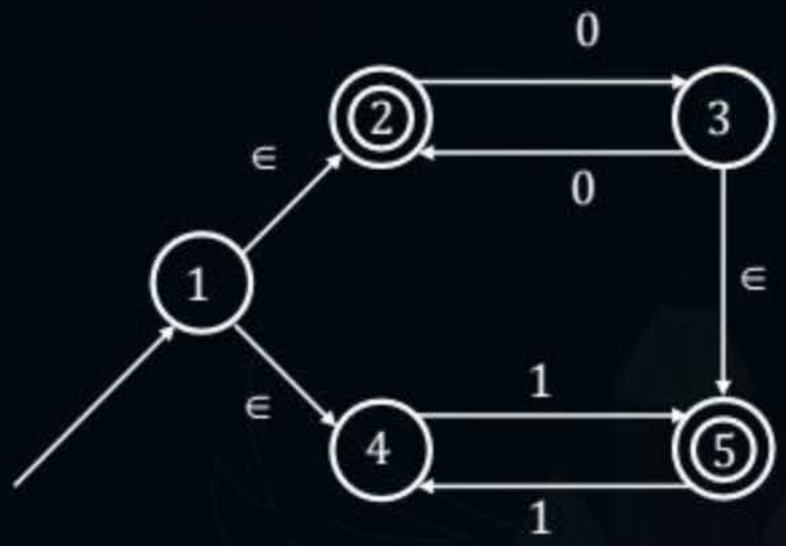
B 4

C 7

D 8

MCQ

#Q. Let M be the 5-state NFA with $\in$ - transitions shown in the diagram below. Which one of the following regular expression represents the language accepted by M?



A $0^* + (1 + 0\ (00)^*)(11)^*$

B $0^+ + 1(11)^* + 0(11)^*$

C $(00)^* + (1+(00)^*)(11)^*$

D $(00)^* + 1(11)^*$

Topic : DFA Construction

Construct DFA for the following Language.

#Q. Construct DFA for the language: $L = \{a^n b^m \mid n > m\}$

#Q. For which of the following languages DFA is possible

1. $L = \{a^n b^m \mid n, m \geq 1\}$

2. $L = \{a^n b^n \mid n \geq 1\}$

3. $L = \{a^n b^m \mid n < m\}$

4. $L = \{a^n b^m \mid n \neq m\}$

5. $L = \{a^n b^m c^{n+m} \mid n, m \geq 1\}$

6. $L = \{a^n b^{2m} \mid n, m \geq 1\}$

MCQ

#Q. Which of the following are regular sets?

1. $\{a^n b^{2m} \mid n \geq 0, m \geq 0\}$
2. $\{a^n b^m \mid n = 2m\}$
3. $\{a^n b^m \mid n \neq m\}$
4. $\{x\, c\, y \mid x, y \in \{a, b\}^*\}$

A 1 and 4 only

B 1 and 3 only

C 1 only

D 4 only

Topic : DFA Construction

Regular Language

{ set }

Construct DFA for the following Language.

1. $L = \{a^n b^m \mid n, m \geq 1\}$ → Regular Language ✓
2. $L = \{a^n b^n \mid n \geq 1\}$
3. $L = \{a^n b^m \mid n < m\}$
4. $L = \{a^n b^m \mid n \neq m\}$ ⟶ non Regular
5. $L = \{a^n b^m c^{n+m} \mid n, m \geq 1\}$
6. $L = \{a^n b^{2m} \mid n, m \geq 1\}$ ⟶ Regular. ✓

Topic : DFA Construction

If comparision exist between symbols of language then DFA is not possible.

Topic : DFA Construction

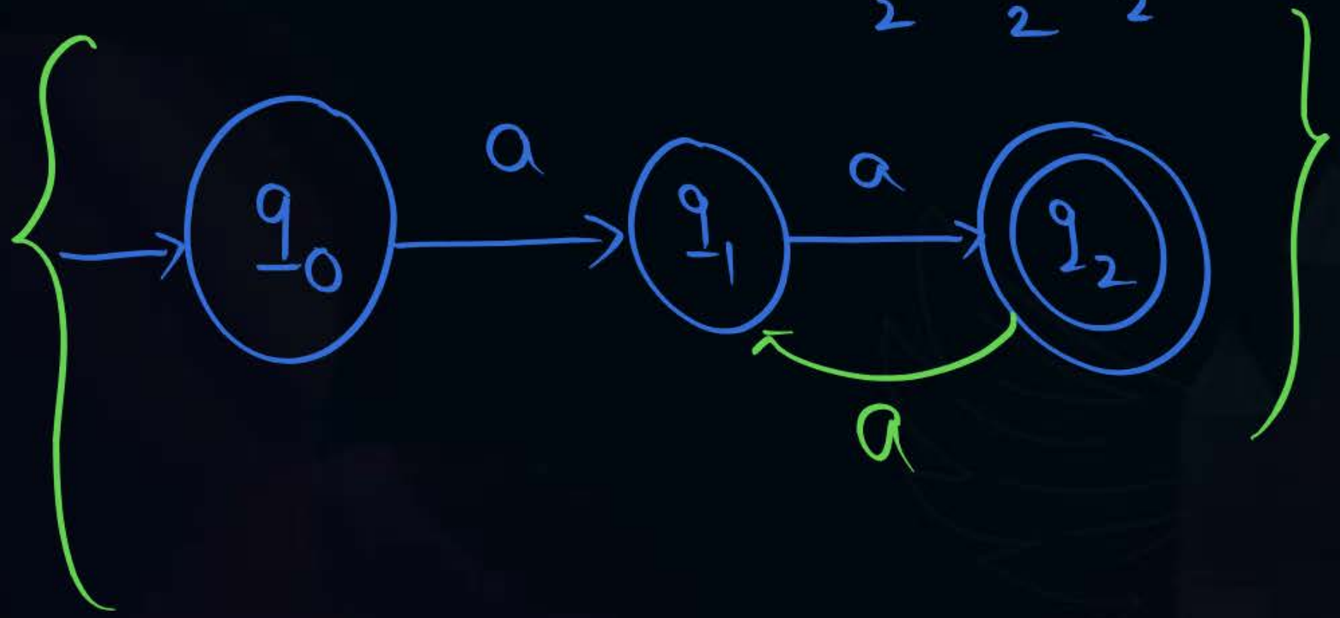
Construct DFA for the following Language.

$L = \{a^{2n} \mid n \geq 1\}$ $\Sigma = \{a\}$

$\{a^2, a^4, a^6, a^8 \dots\}$

2 2 2

3 states



Topic : DFA Construction

Construct DFA for the following Language.

$L = \{ a^{3n} \mid n \geq 1 \}$

$\{ a^3, a^6, a^9, a^{12} \ldots \}$

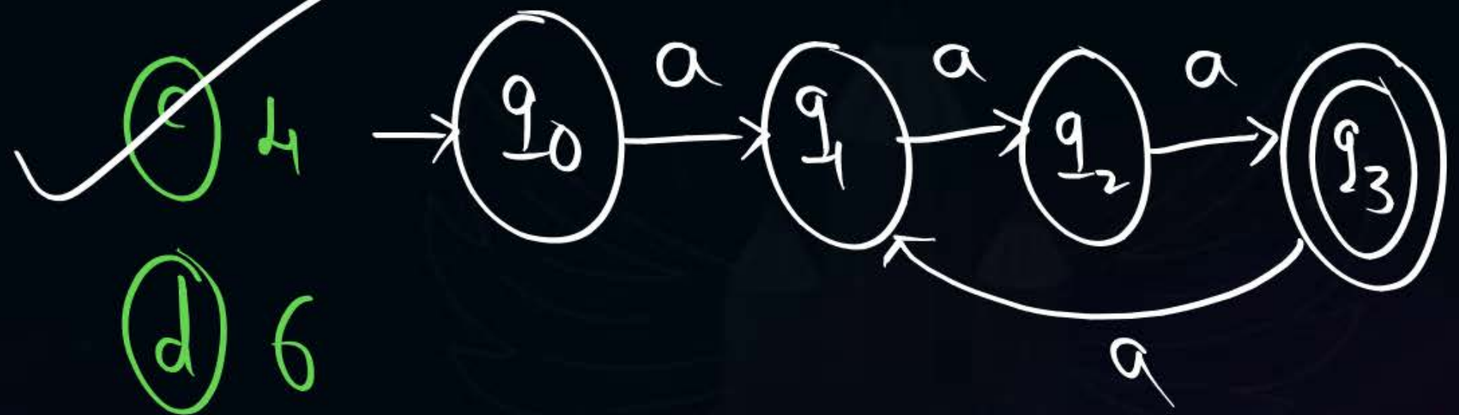
3 3 3

(a) 2

(b) 3

(c) 4

(d) 6

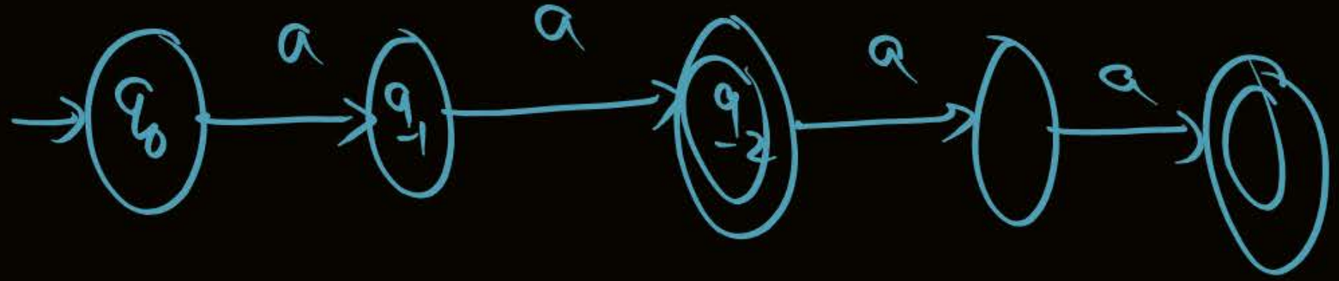


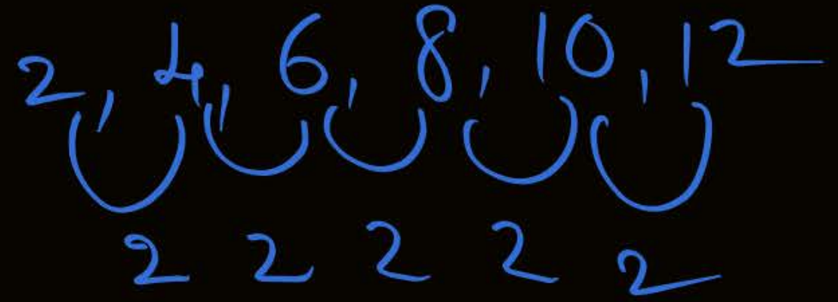
$L = \{ a^{2^n} \mid n \geq 1 \}$ ⟵ DFA not possible

How many states in DFA

(a) 2 (b) 4 (c) 8 (d) none

$\{ a^2, a^4, a^8, a^{16} \cdots \}$




2, 4, 6, 8, 10, 12
2 2 2 2 2

Which of the following is Regular? lang

not Reg

(a) $L = \{a^{n^n} / n \geq 1\} = \{a^1, a^2, a^3, \ldots\}$

not Reg

(b) $L = \{a^{n!} / n \geq 1\} = \{a^1, a^2, a^6, \ldots\}$

not Reg

(c) $L = \{a^{3^n} / n \geq 1\} = \{a^3, a^{3^2}, a^{3^3} \ldots\}$

(d) none

if a language is formed by 1 symbol

Common difference exist → DFA possible

no " " " → DFA not possible

Topic : DFA Construction

Construct DFA for the following Language.

Topic : DFA Construction

Construct DFA for the following Language.

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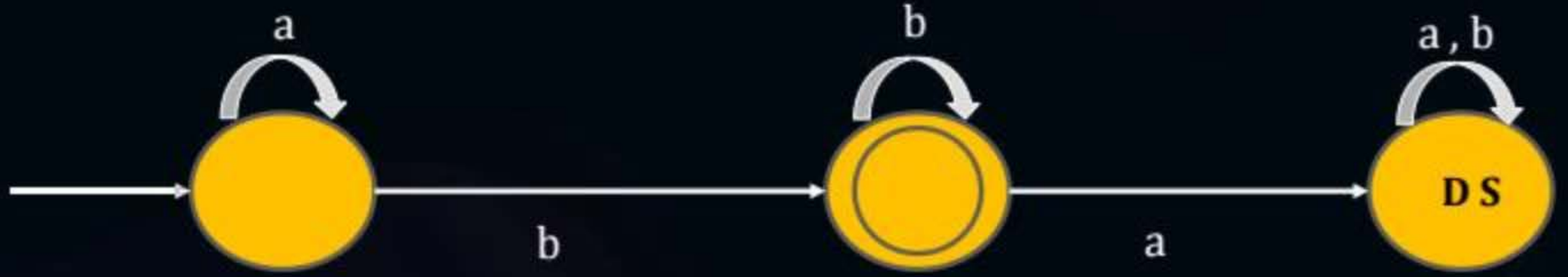
Topic : DFA Construction

Construct DFA for the following Language.

#Q. Identify language accepted by following DFA



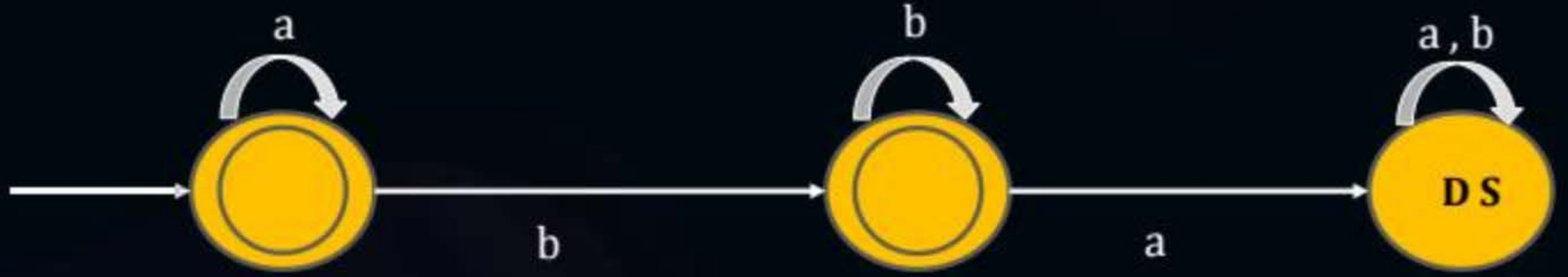
A $L = \{a^n b^m \mid n, m \geq 1\}$

B $L = \{a^n b^m \mid n \geq 1, m \geq 0\}$

C $L = \{a^n b^m \mid n, m \geq 0\}$

D None

#Q. Identify language accepted by following DFA



A $L = \{a^n b^m \mid n, m \geq 1\}$

B $L = \{a^n b^m \mid n \geq 1, m \geq 0\}$

C $L = \{a^n b^m \mid n, m \geq 0\}$

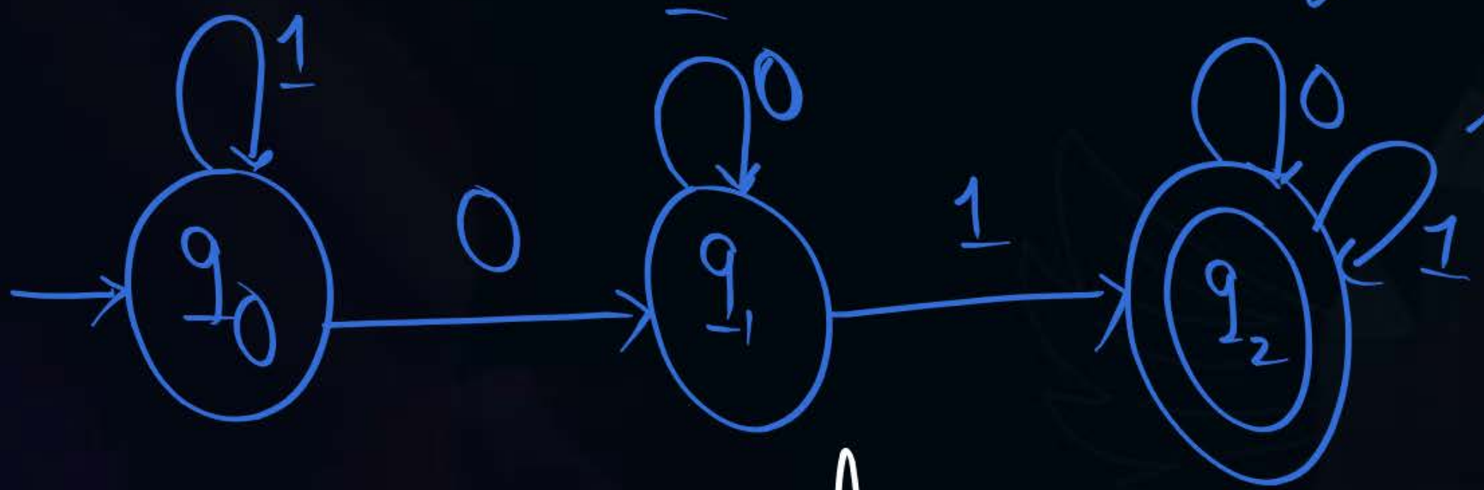
D None

Topic : DFA Construction

any (0·5 / 1·5) 01 (any (0·5 / 1·5))

Construct minimal state DFA that accepts all strings of 0's and 1's where each string contains substring 01.

{01, 101, 001, 011, ---} 0 000 1111



3 states

Substring (min DFA)

2 length Substring → 3

3 " " → 4

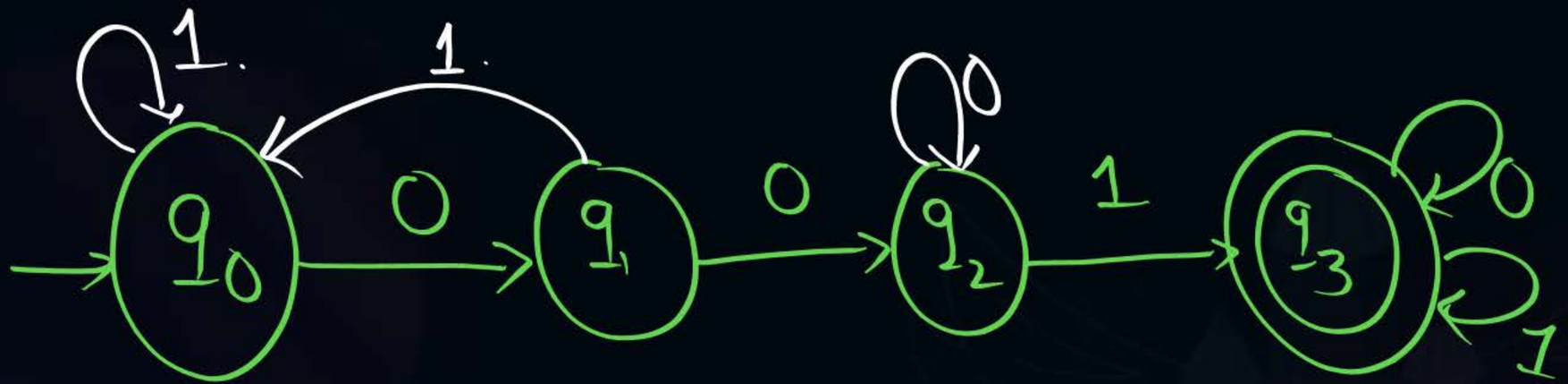
4 " " → 5

η " " → ($\eta+1$) state

Topic : DFA Construction

(a) 3 (b) 4 (c) 5 (d) 6

Construct minimal state DFA that accerpts all strings os 0's and 1's where each string contains substring 001 {001, 0001, 1001, 0011 - - -}



4 states

0 1 0 0 1 1 0 0 1 0 0 0 1

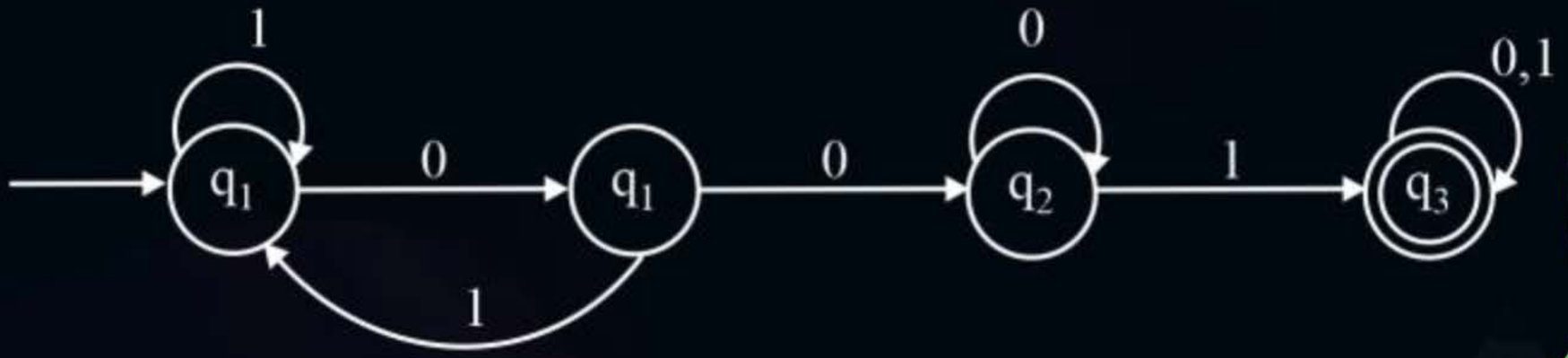
Topic : DFA Construction

Construct minimal DFA that accerpts all strings os 0's and 1's where each string contains substring 0101

5 states

MCQ

#Q. Consider the following deterministic finite automata m.



not having Substring 001

The language accepted by finite automata, which is obtained by interchanging final and non-final states in m, is-

A The set of all strings containing 001 as the subtrings

B The set of all strings not containing 001 as the subtrings

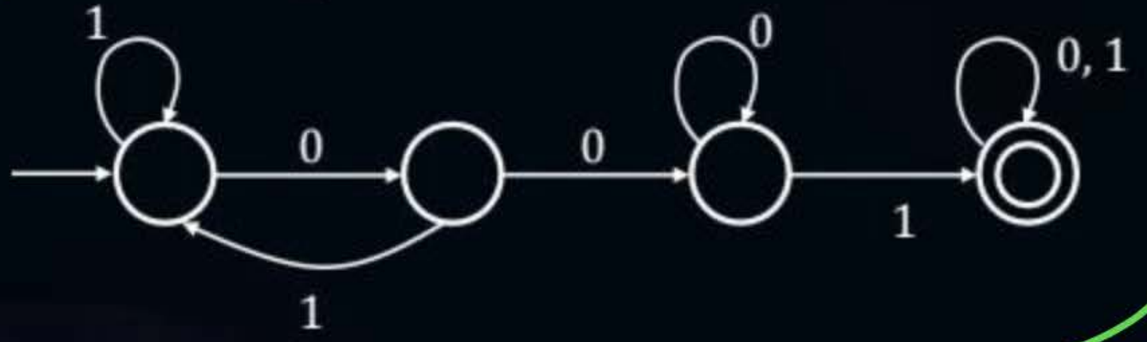
C The set of all strings ending with subtrings 001

D The set of all strings ending with subtrings 001

MCQ

Sub string 001 Sub string 001

#Q. Consider the following deterministic finite state automaton M.



M

Let S denote the set of seven-bit binary strings in which the first, the fourth, and the last bits are 1. The number of strings in S that are accepted by M is

S: 1 0 0 1 4 1 } 16

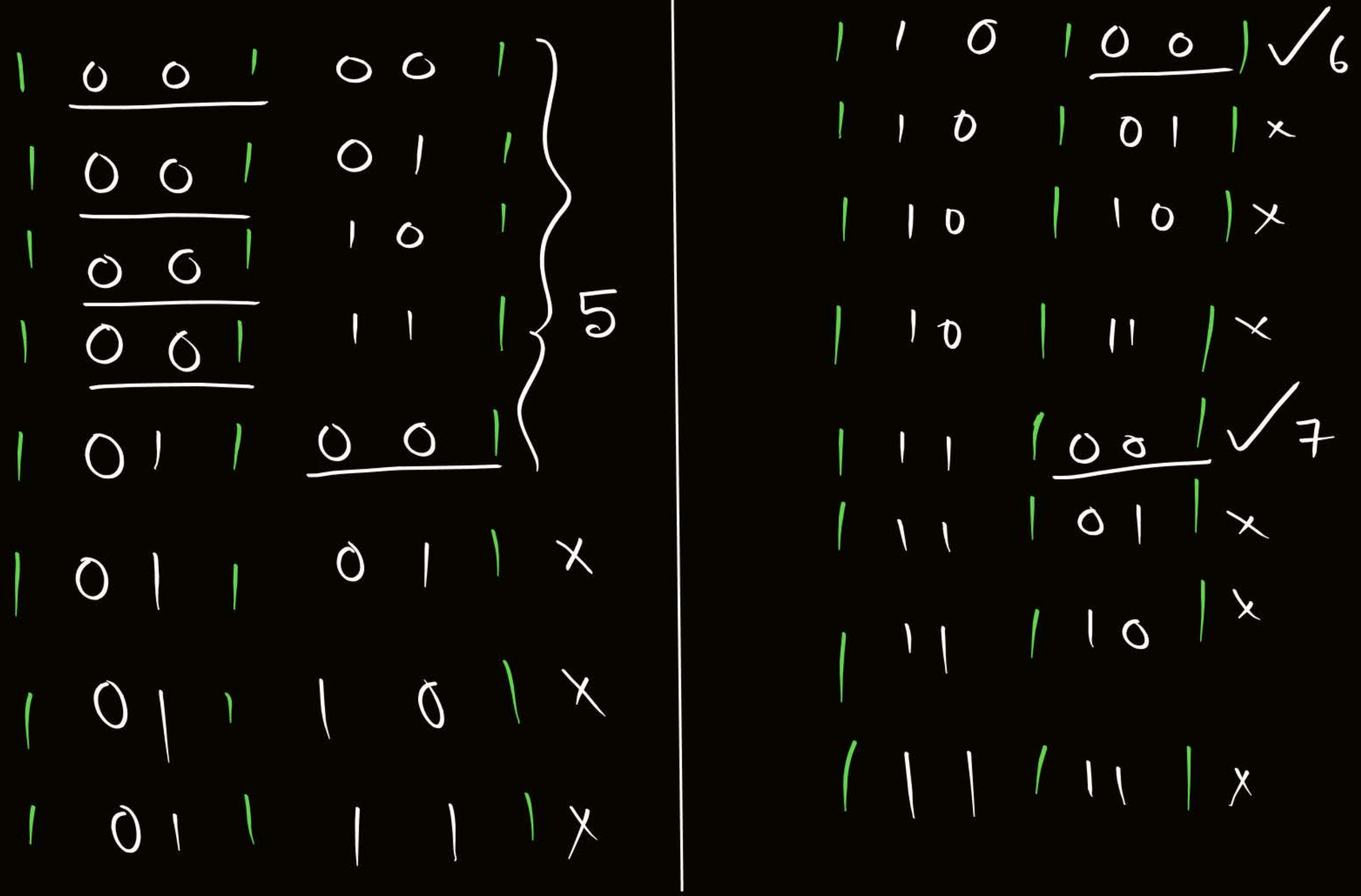
0 1 0 1 0

A 1

B 5

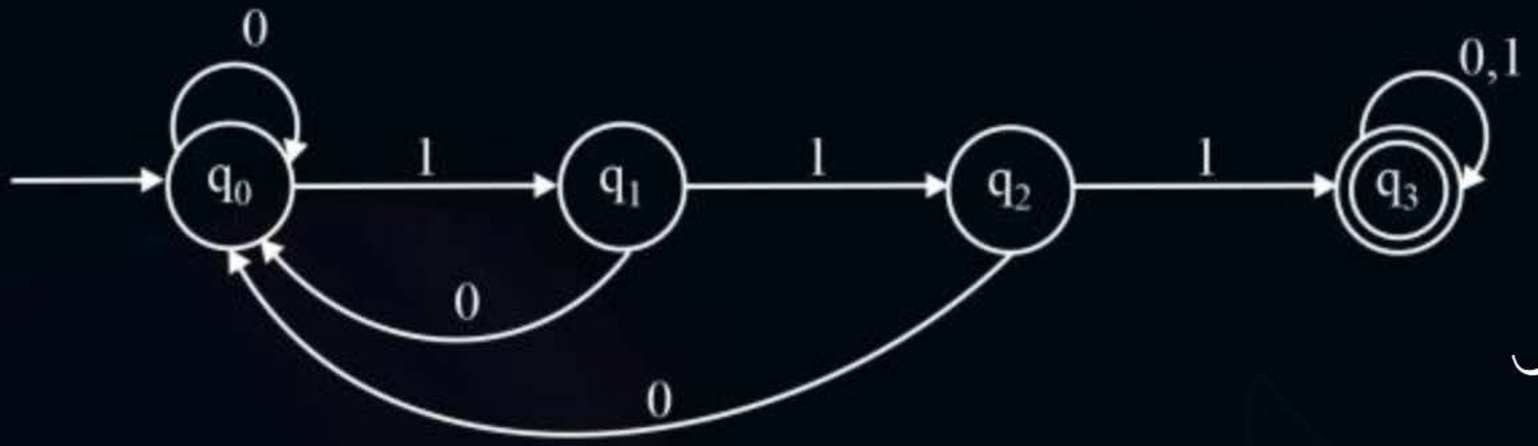
C 7 ✓

D 8


00 00
00 01
00 10
00 11
01 00
5
01 01 x
01 10 x
01 11 x
10 00 ✓6
10 01 x
10 10 x
10 11 x
11 00 ✓7
11 01 x
11 10 x
11 11 x

MCQ

#Q. Consider the finite automata m.



} Substring 111

The language accepted by m is, over the alphabet {0,1}

Substring

A The set of all strings containing three consecutive 1's

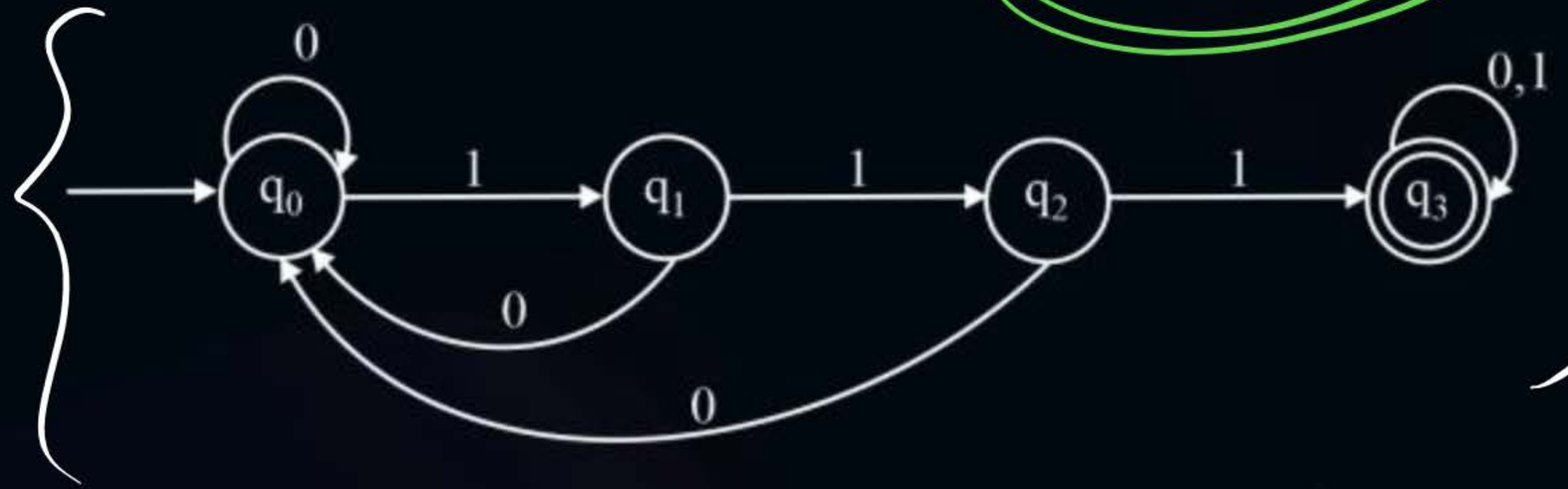
B The set of all strings not containing three consecutive 1's

C The set of all strings beginnigs with three consecutive 1's

D The set of all strings ending with three consecutive 1's

MCQ

#Q. Consider the finite automata m.



$\Sigma = \{0, 1\}$

Sub string
111

Let S denotes the set of all six bit binary strings in which first and fourth bits are 1. The number of strings in S that are accepted by m is-

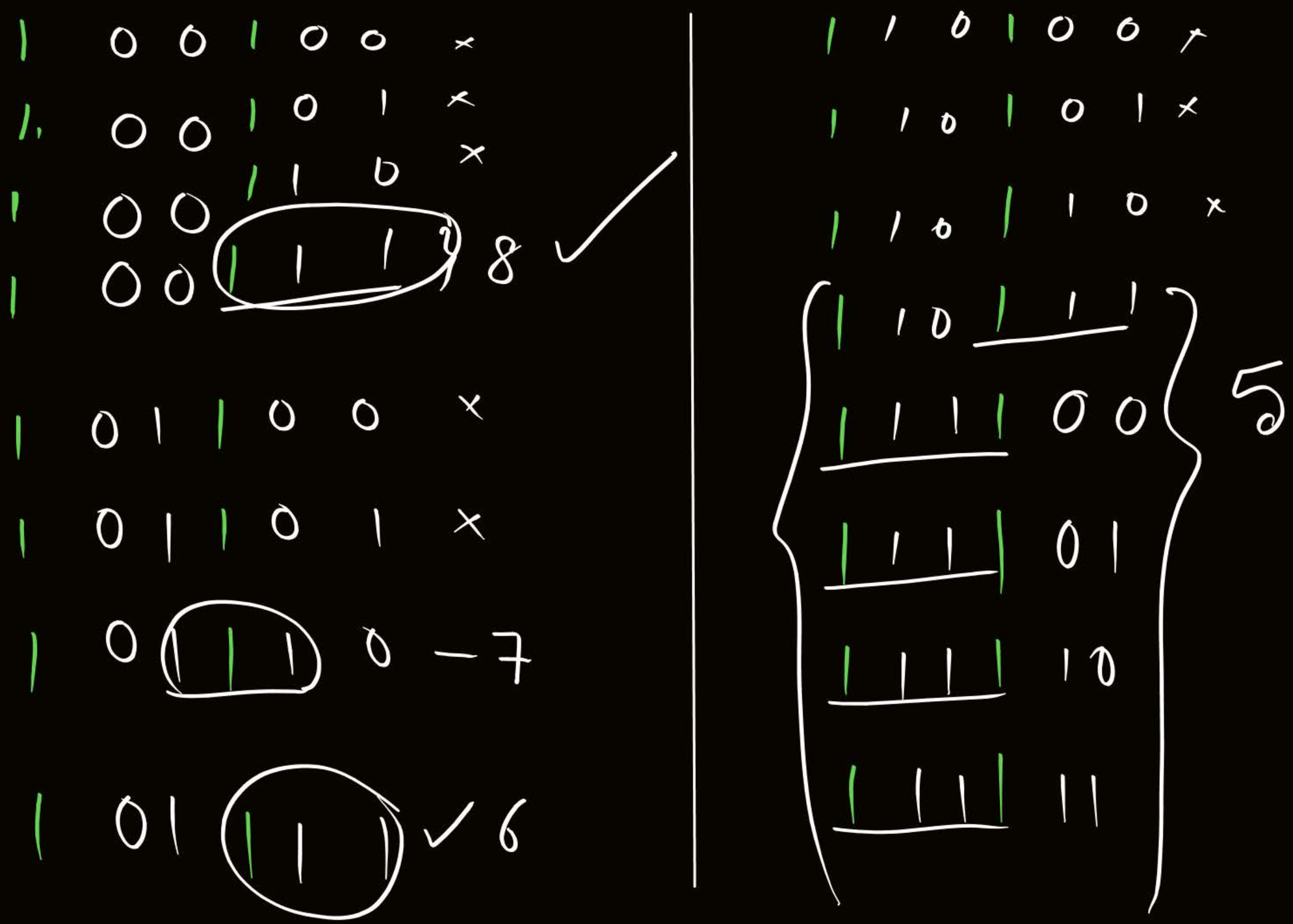
S: 1 { 4 } 1 { 4 } 1

A 1

B 4

C 7

D 8


8
5
-7
6

Topic : DFA Construction

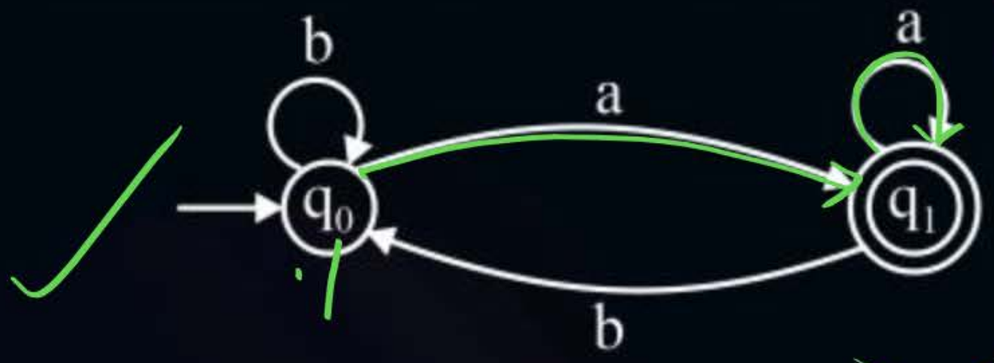
Construct DFA for

Topic : Complement of DFA

{a, b} A → set

U - A {U - A}

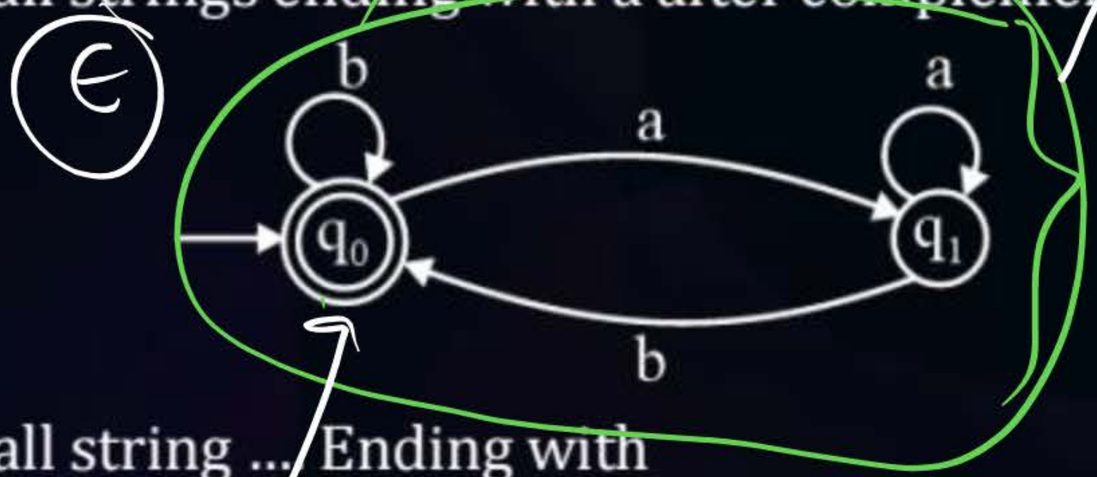
By interchanging final and non final states we can convert into complement DFA.



not ending with a L^c

$L = \Sigma^* - L$

Set of all strings ending with a after complement



Set of all string ... Ending with

(a) ending with a

(b) ending with b {b, ab, bb ...}

(c) both

(d) none.

not having Sub string 001.

VENKAT SIR PW

members, 3 online

550

Info

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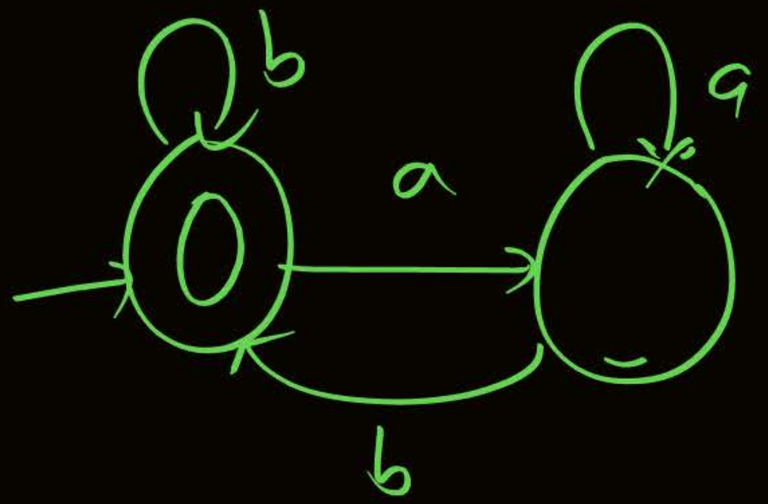

not ending with a

THANK - YOU