CS & IT ENGINEERING

Theory of Computation

Finite Automata

Lecture No. 20

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TOPICS TO BE COVERED

01 Regular & Non regulars

02 GATE PYQs & Pending

03 Revision of all topics

04

05

H.W.:

65. $ww x$
66. wxw
67. xww
68. $ww^R x$
69. wxw^R
70. xww^R

$w, x \in \{a, b\}^*$

When you put $w = \epsilon$

$= x$

$= (a+b)^*$

All are regular

(71) $\{wwx \mid w, x \in \{a,b\}^+\}$

(72) $\{wxw$ ''

(73) $\{xww$ ''

(74) $\{ww^Rx$ ''

Reg ***(75) $\{wxw^R$ ''

(76) $\{xww^R$ ''

before

a/k

} ayat+bxb, aayaa ✓, abyab ✗

} xaa+xbb, xaaaa ✓, xabab ✗

} aax+bbx, aaaax ✓, abbax ✗

} = axa+bxb

xaa+xbb

} xaaaa ✓, xabbax

Except 75, All are not regular.

1st: put min string inplace of w and find the form

2nd: If the above form covers whole language then it is reg.

(71) $\{wwx \mid w, x \in \{a,b\}^+\}$ $\Rightarrow$ Not reg

min w: $w = a/b$

$aa(a+b)^+$

OR

$bb(a+b)^+$

1st form

2nd min: $w = aa/ab/ba/bb$

aaaax ✓

ababx $\rightarrow$ X

babax

bbbbx

2nd form

2nd form some strings are missing in 1st

(75) $\{wxw^R \mid w, x \in \{a,b\}^+\}$ $\Rightarrow$ Regular

1st: $w = a/b$

$axa + bxb$

2nd: $w = aa/ab/ba/bb$

aaxaa ✓

abxba ✓

baxab ✓

bbxbb ✓

all are covered

$= a(a+b)^+a + b(a+b)^+b$

(75) $\{wxw^R \mid w, x \in \{a,b\}^+\}$

after before

$= a(a+b)^+a + b(a+b)^+b$

$= \{wxw^R \mid w, x \in \{a,b\}^+, \ |w| = 1\}$

$= \{w \mid w \in \{a,b\}^*$, w starts & ends with same i/p, $|w| \geq 3\}$

Note: $L = \{w \mid w \in \{a,b\}^*$, w starts and ends with same i/p symbol$\}$

$= a + b + a(a+b)^*a + b(a+b)^*b$

(77) $\{ wxwy \mid w, x, y \in \{a,b\}^+ \}$

$= a(a+b)^+ a(a+b)^+ + b(a+b)^+ b(a+b)^+$

1st: $axay + bxby$

2nd: aaxaay ✓
abxaby ✓
baxbay ✓
bbxbby ✓

(78) $\{ xwyw \mid w, x, y \in \{a,b\}^+ \}$

before before

1st: $xaya + xbyb$

Ans

2nd: xaayaa
xabyab
xbayba
xbbybb

(79) $\{ xwywz \mid w, x, y, z \in \{a,b\}^+ \}$

$xayaz + xbybz$

(80) $\{ xww^R y \mid w, x, y \in \{a,b\}^+ \}$

before after

$xaay + xbby$

Ans:

xaaaay ✓
xabbay ✓
xbaaby
xbbbby

(81) $\{wxwy \mid w,x,y \in \{a,b\}^*\}$

(82) $\{xwyw \mid w,x,y \in \{a,b\}^*\}$

(83) $\{xwywz \mid w,x,y,z \in \{a,b\}^*\}$

(84) $\{xww^Ry \mid w,x,y \in \{a,b\}^*\}$

put $w=\epsilon$

$= x$

$= (a+b)^*$

all are regular

$bxby$

$axay$

$$\{wxwy \mid w, x, y \in \{a,b\}^+\}$$

After After

Why we substitute only w?

w is repeating.

To check dependency b/w i/p symbols

(85) $\{ xwxw \mid w, x \in \{a,b\}^+ \}$ ⟹ Not regular

(86) $\{ p\,x\,r\,w\,q\,x\,s\,w \mid w, x, p, q, r, s \in \{a,b\}^+ \}$

(87) $\{ p\,\boxed{x}\,q\,\boxed{x}\,r\,\boxed{w}\,s\,\boxed{w}\,t \mid w, x, p, q, r, s, t \in \{a,b\}^+ \}$

before before after after

Regular ⟸

(88) $\{\boxed{x}w\boxed{x} \mid x, w \in \{a,b\}^+\}$ $\Rightarrow$ Not reg

(89) $\{\boxed{x}w\boxed{x}y \mid x, w, y \in \{a,b\}^+\}$ $= away + bwby$ $\Rightarrow$ Regular

(90) $\{\boxed{y}w\boxed{y}x \mid w, x, y \in \{a,b\}^+\}$ $= awax + bwbx$

(91) $\{wxyw \mid w, x, y \in \{a,b\}^+\}$ $\Rightarrow$ Not regular

(92) $\{ \boxed{ww} \# \boxed{ww} \mid w \in \{a,b\}^* \}$ ⇒ Not regular

(93) $\{ \cancel{w}\cancel{w}x\cancel{w}\cancel{w} \mid w, x \in \{a,b\}^* \} = (a+b)^*$ ⇒ Reg

$\epsilon \quad \epsilon \quad \epsilon \quad \epsilon$

(94) $\{ \cancel{w}\cancel{x}\cancel{w}\cancel{x}\cancel{w}\cancel{x}\cancel{w}y \mid w, x, y \in \{a,b\}^* \}$

(95) $\{ ww^R ww^R ww^R \mid w \in a^* \} = (a^6)^*$

$wwwwww$

$\boxed{\text{Over 1 symbol } w = w^R}$

⇓ Regular

(96) $\{w \mid w \in \{0,1\}^*,\ n_0(w) = n_1(w)\}$

000000

(97) $\{w \mid w \in \{0,1\}^*,\ n_{00}(w) = n_{11}(w)\}$

000000

Rev ~~(98)~~ $\{w \mid w \in \{0,1\}^*,\ n_{\underline{01}}(w) = n_{\underline{10}}(w)\} \Rightarrow$ Regular

0101001

(99) $\{w \mid w \in \{0,1\}^*,\ n_{01}(w) = n_{00}(w)\}$

0101010101

(100) $\{w \mid w \in \{0,1\}^*,\ n_{000}(w) = n_{111}(w)\}$

000000000000

Rev ~~(101)~~ $\{w \mid w \in \{0,1\}^*,\ n_{\underrightarrow{001}}(w) = n_{\underleftarrow{100}}(w)\} \Rightarrow$ Regular

0100100101

(102) $\{1, 2^1, 2^2, 2^3, \ldots, 2^k, \ldots\}$ in $\underbrace{\text{binary}}$

$\Downarrow$ Regular

$1 \to \ldots 001$

$2^1 \to \ldots 0010$

$2^2 \to \ldots 000100$

$2^3 \to \ldots 001000$

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

$$\boxed{L = 0^* 1 0^*}$$

$$\boxed{\ldots 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0}$$ Binary representation

(103) $L = \{1, 2^1, 2^2, 2^3, \ldots, 2^k, \ldots\}$ in $\underbrace{\text{unary}}$

$1, 2, 4, 8$

Over 1 symbol

$$= \{a^{2^n} \mid n \geq 0\} = \{b^{2^n} \mid n \geq 0\}$$

$\Rightarrow$ Not regular

Q.9 If R1= a*, and R2=(aa)* then R1.R2=____

A. R1 $= a^*$
B. R2.R1 $= a^*$
C. R1+R2 $= a^*$
D. All of these ✓

$$\underbrace{a^*}_{a^*} \cdot \underbrace{(aa)^*}_{\varepsilon} = a^*$$

$$\varepsilon \rightarrow \boxed{a^*}$$

$$a^* \cdot aa$$

$$a^* \cdot a^4$$

(2) If the regular set A is represented by $A = (01+1)^*$ and the regular set 'B' is represented by $B = ((01)^*1^*)^*$, which of the following is true? **(GATE - 98)**

(a) $A \subset B$

(b) $B \subset A$

(c) A and B are incomparable

(d) $A = B$ ✓

$01 = x$

$1 = y$

$A = (x+y)^*$

$B = (x^* y^*)^*$

$\boxed{A = B}$

$$(01+1)^* = (x+y)^*$$

$$((01)^* 1^*)^* = (x^* y^*)^*$$

3. The string 1101 does not belong to the set represented by (GATE - 98)

(a) $110^* (0+1)$ ← 110(1)

(b) $1(0+1)^* 101$ ← 1( )101

(c) $(10)^* (01)^* (00+11)^*$

(d) $(00+(11)^* 0)^*$ → 110110 ≠ 1101

1101 ∉ (c)   1101 ∉ (d)

substring   string

1101 is string ∉ L

1101 ∈ (a)

1101 ∈ (b)

(5) H.W.

Consider the set $\sum^*$ of all strings over the alphabet $\sum = \{0, 1\}$. $\sum^*$ with the concatenation operator for strings **(GATE - 03)**

(a) Does not form a group

(b) Forms a non-commutative group

(c) Does not have a right identity element

(d) Forms a group if the empty string is removed from $\sum^*$

(In discrete maths)

Group Theory

closure ?

Associative ?

Identity ?

Inverse ?

Commutative ?

H.W. : Group ?

Group Theory

$$\left.\begin{array}{l}\to \text{closure}\\ \to \text{Associative}\end{array}\right\}\text{Semigroup}$$

- → Identity
- → Inverse
- → Commutative

Monoid

Group

Abelian

Model-6:

H.W.

(5) $L = b^*a^*$

(6) $L = b^+a^*$

(7) $L = b^*a^+$

(8) $L = b^*a^*$

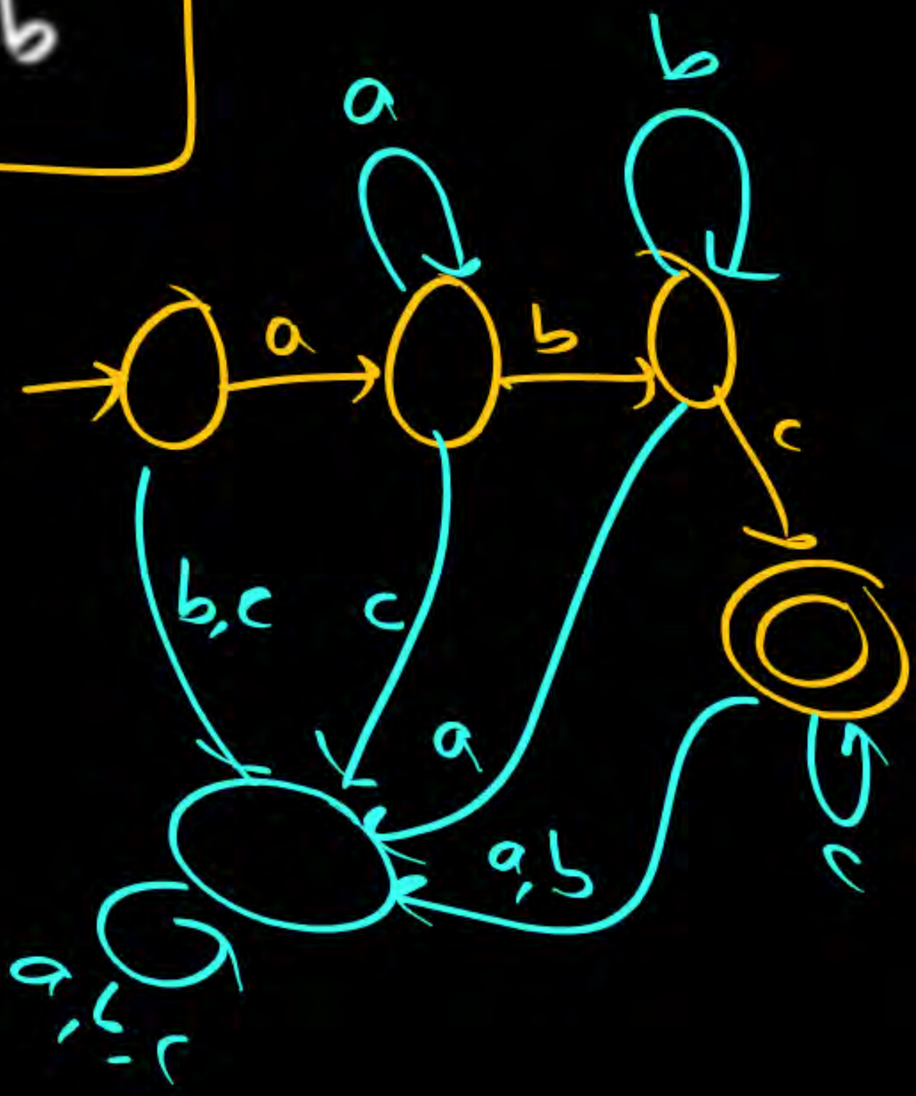
$\Sigma = \{a, b\}$

(9) $L = a^+b^+c^+$

(10) $L = b^+a^+c^+$

(11) $L = c^+a^+b^+$

(9) $\Sigma = \{a, b, c\}$

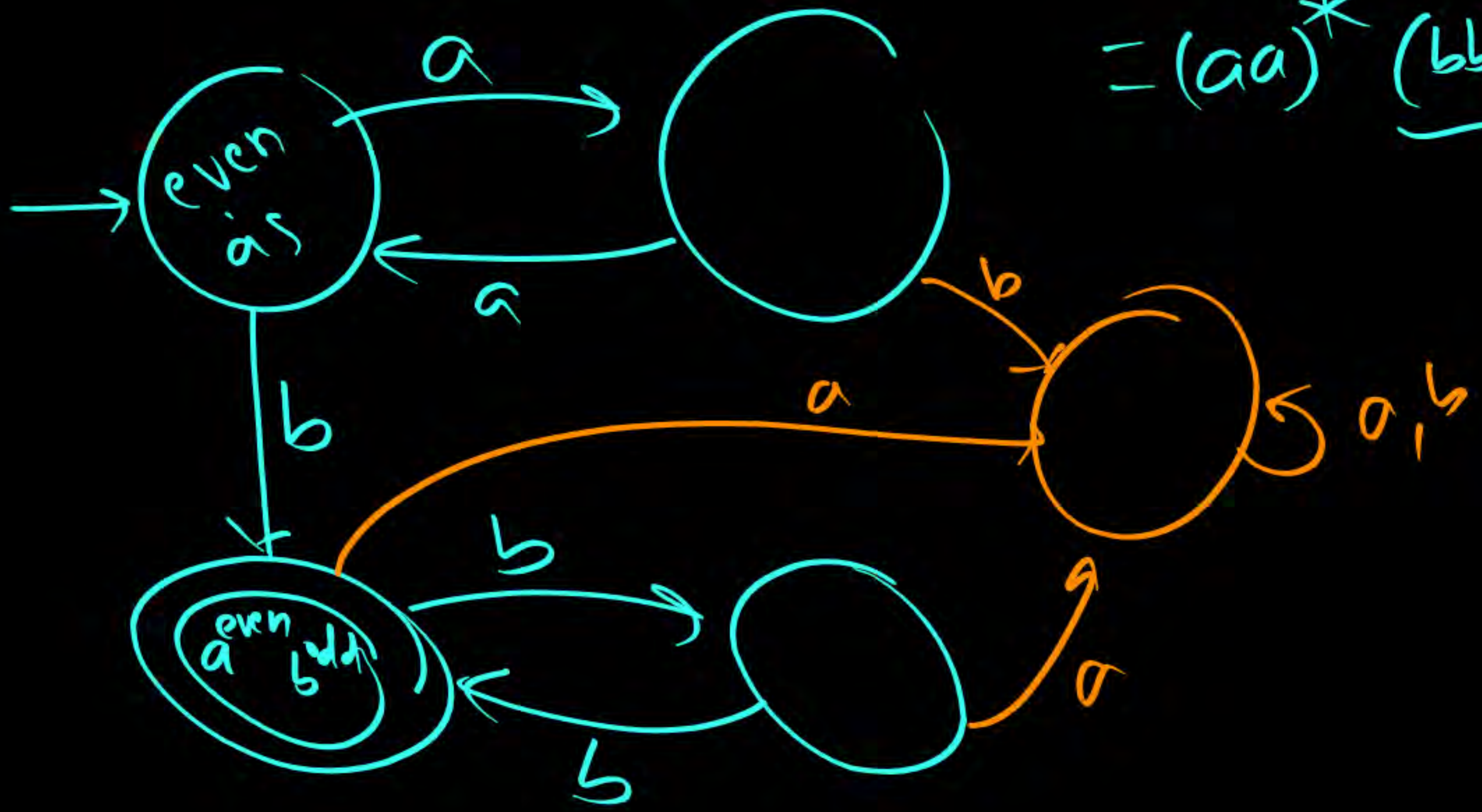


Model-7:

(19) $\{a^m b^n \mid m = \text{even}, n = \text{odd}\} = a^{\text{even}} b^{\text{odd}}$

$= (aa)^* \, b(bb)^*$

$= (aa)^* \, (bb)^* b$



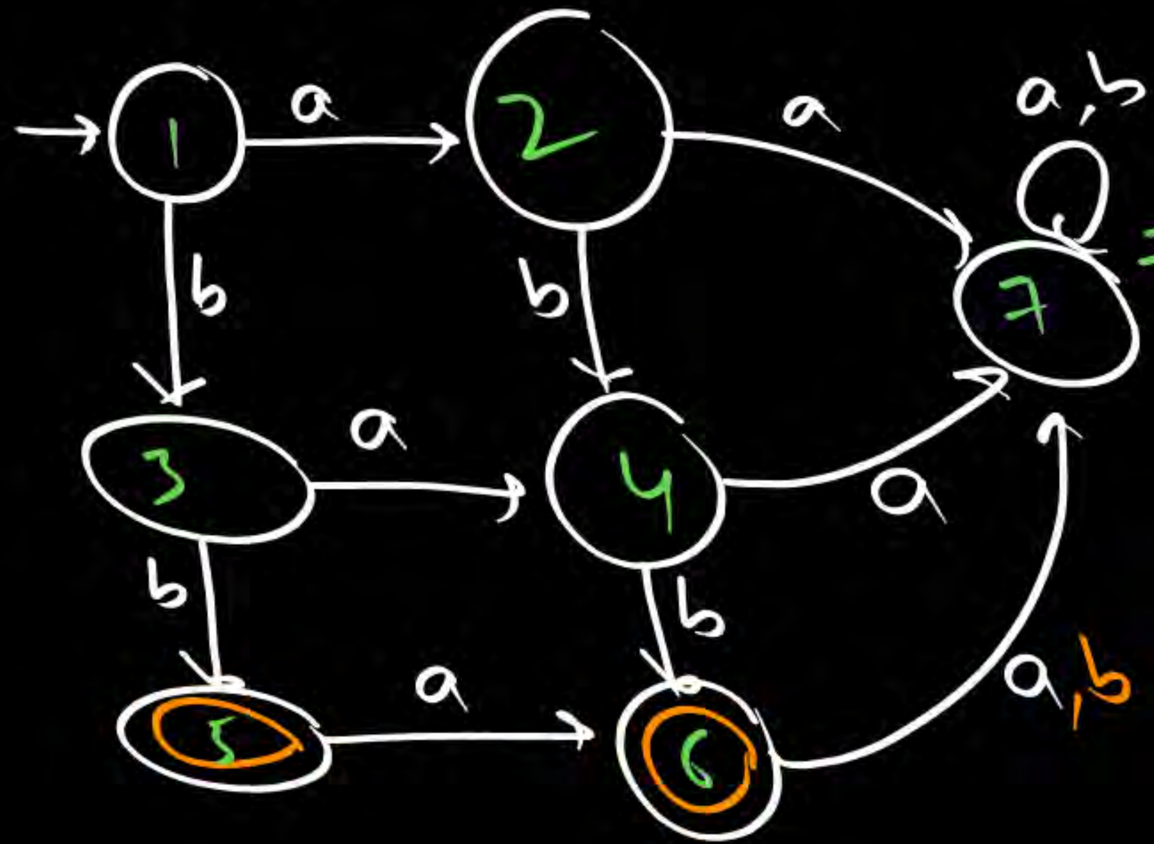
Model-8:

(3) $\{w \mid$ " , $n_a(w) \le 1,\ n_b(w) = 2\}$

(4) $\{w \mid$ " , $n_a(w) \le 1,\ n_b(w) \le 2\}$

(5) $\{w \mid$ " , $n_a(w) \ge 1,\ n_b(w) \le 2\}$

(3)



(4)

$\Longrightarrow$ copy
make 1 to 6 final

(5)

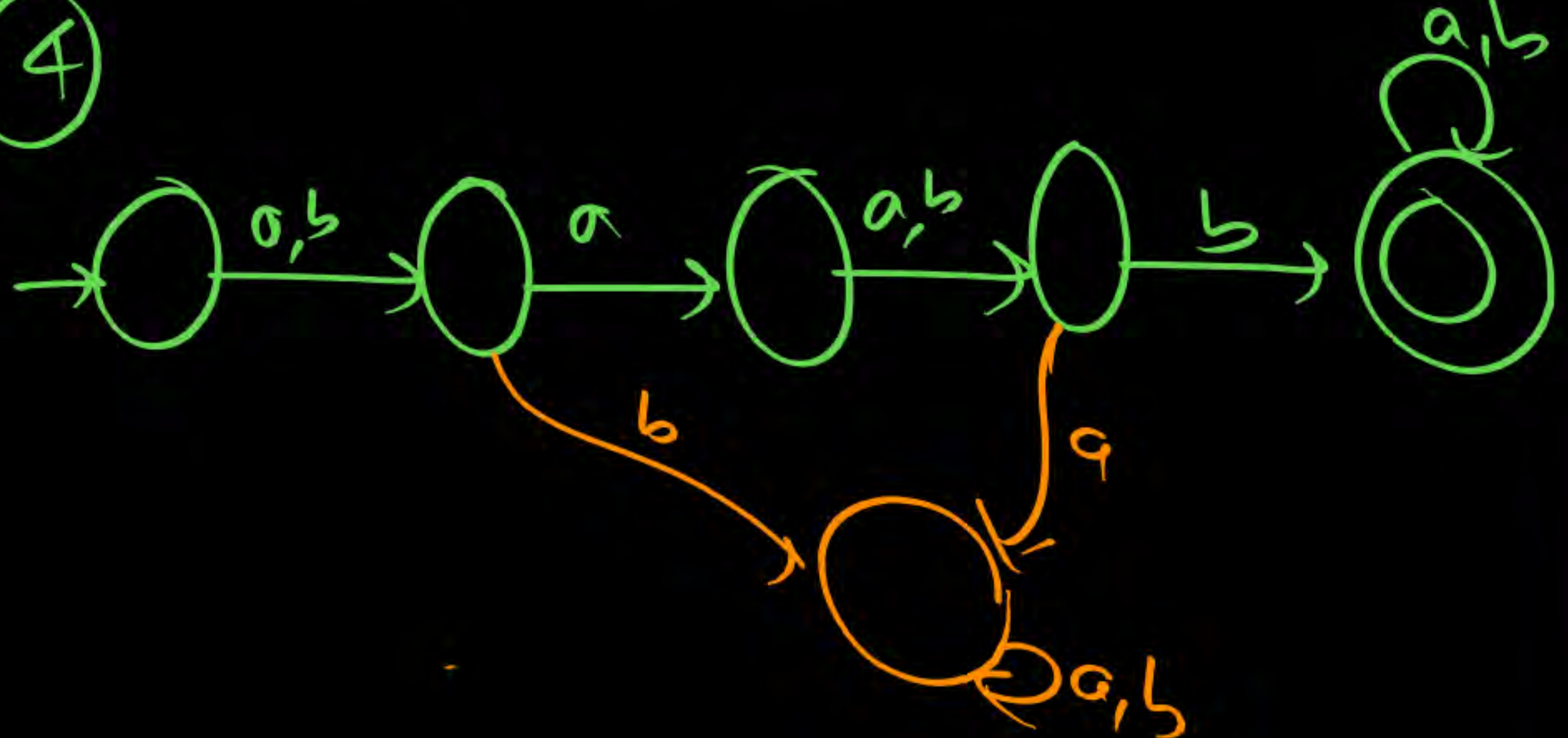
H.W.

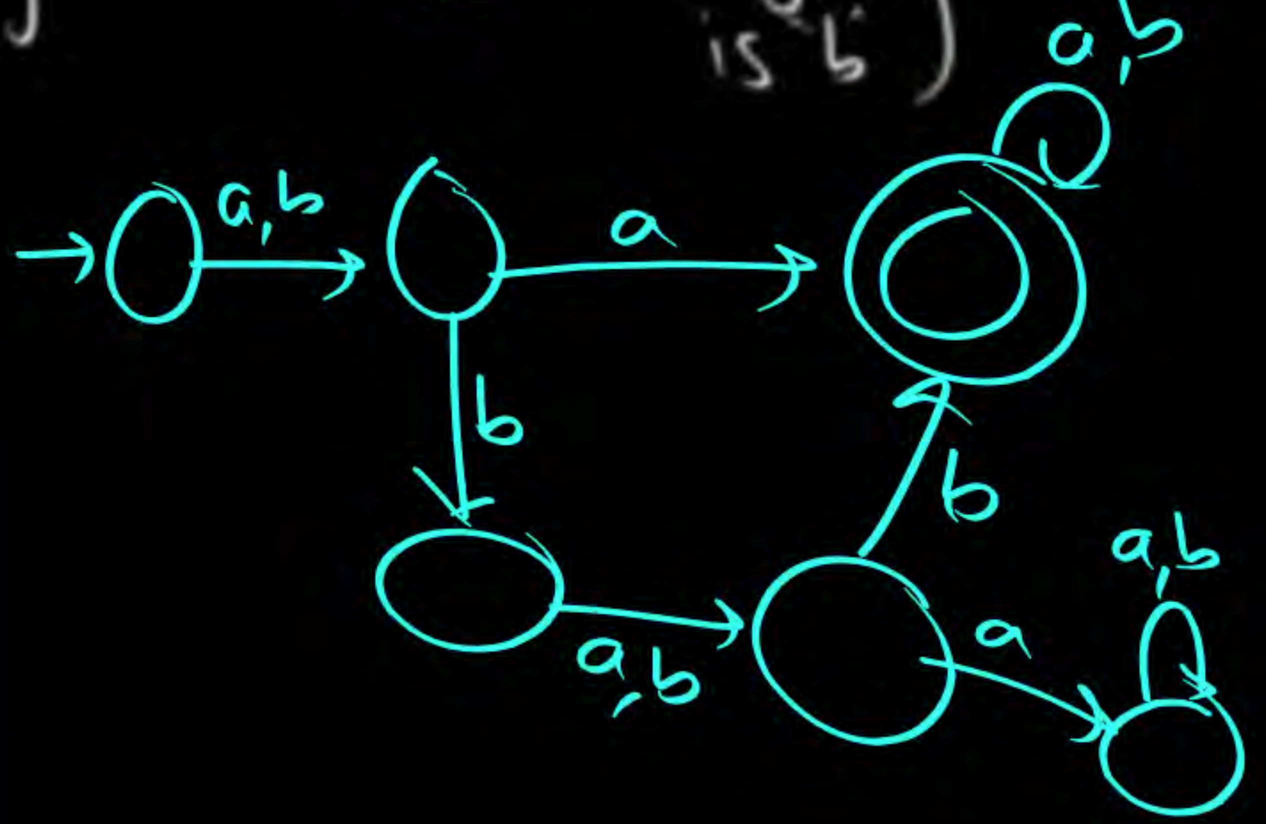
Model-12:

(4) $L = \{w \mid$ " , 2^{nd} symbol is 'a' $\boxed{\text{AND}}$ 4^{th} symbol is 'b' $\}$

(5) $L = \{w \mid$ " , 2^{nd} symbol is 'a' $\boxed{\text{OR}}$ 4^{th} symbol is 'b' $\}$

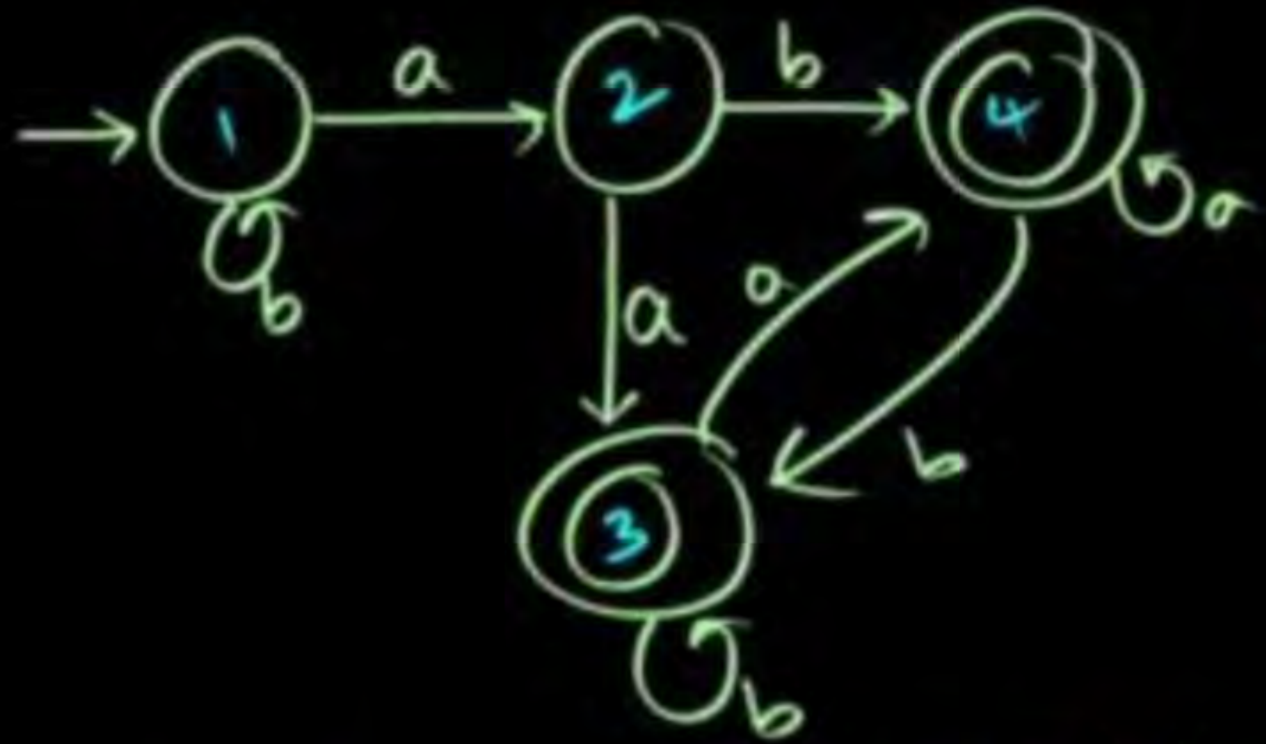
(4)



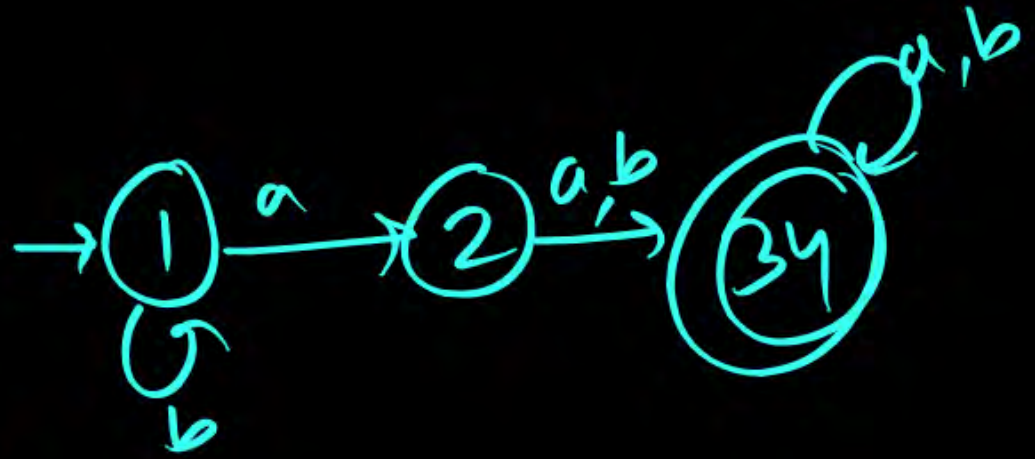


DFA Minimization

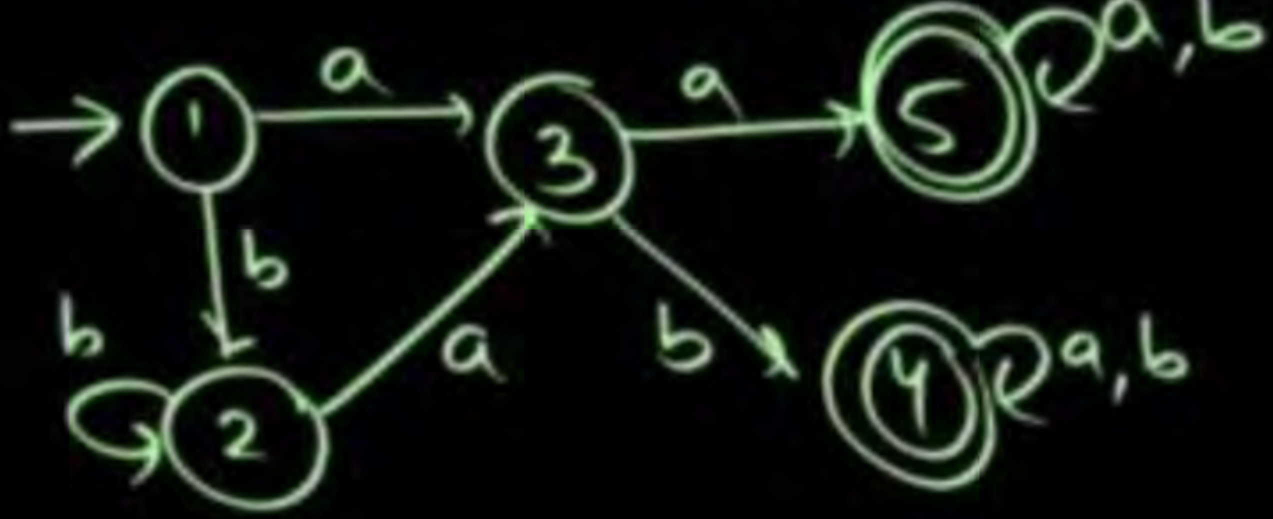
HW 1)

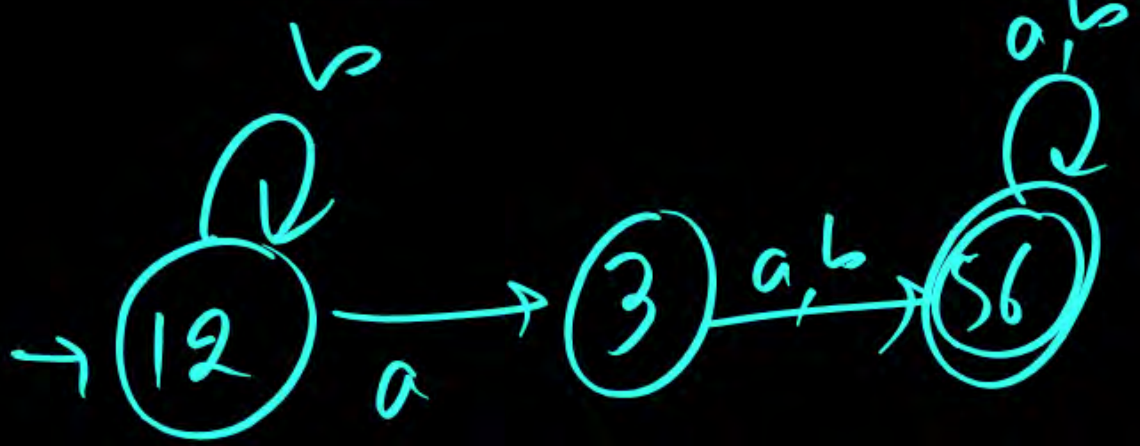


$\Longrightarrow$



2)





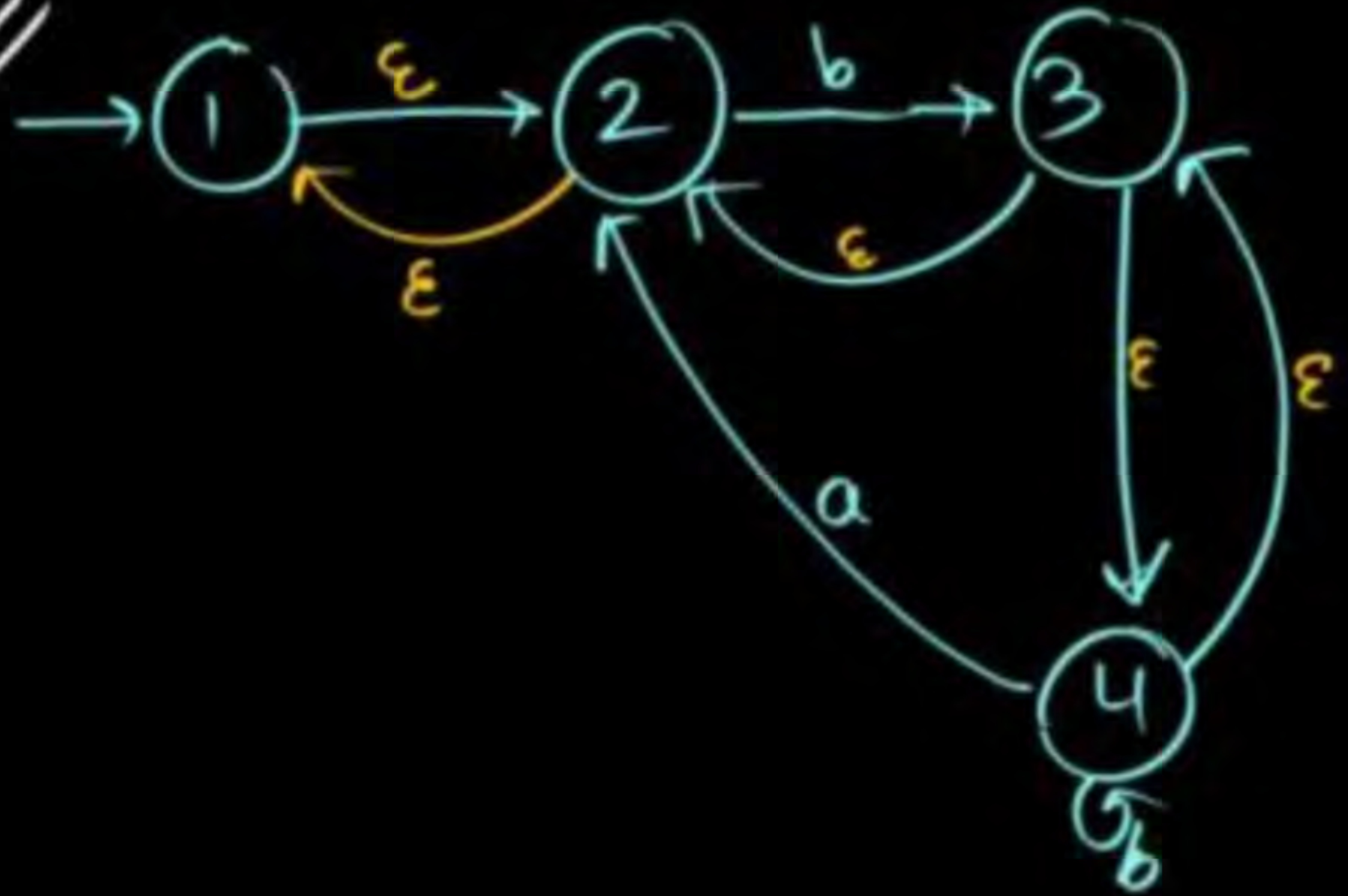
Model-13:

prefix ③ $L = \{ w \mid w \in \{0,1\}^*$, every prefix P of w satisfies $|n_0(P) - n_1(P)| \le 1 \}$

$L = \{\varepsilon, 0, 1, \cancel{00}, 01, 10, \cancel{11}, \dots\}$

w	$\varepsilon \in L$	$0 \in L$	$1 \in L$	$00 \notin L$	01 ✓	10 ✓	$11 \notin L$	$000 \notin L$
Prefixes(w)	ε ✓ $\lvert 0-0 \rvert = 0$	ε, 0 $\lvert 1-0 \rvert \le 1$	ε, 1	ε ✓ 0 ✓ $\boxed{00}$ $\lvert 2-0 \rvert \ne 1$	ε 0 01	ε 1 10	ε 1 $\boxed{11}$ $\lvert 0-2 \rvert \ne 1$	ε 0 00 × 000 ×

H.W.



$$\hat{\delta}(1, \underline{a}ab) = \phi$$

$$\hat{\delta}(2, bb) = \{3, 2, 1, 4\}$$

$$\hat{\delta}(3, bab) = \{3, 2, 1, 4\}$$

$$\hat{\delta}(4, ab) = \{1, 2, 3, 4\}$$

Let L be the language represented by the regular expression $\Sigma^*0011\Sigma^*$ where $\Sigma=\{0,1\}$. What is the minimum number of states in a DFA that recognizes $\overline{L}$ (complement of L)?

(GATE – 15 – SET3)

(a) 4 (b) 5

(c) 6 (d) 8

min ⇒ 0011

⇓

5 states

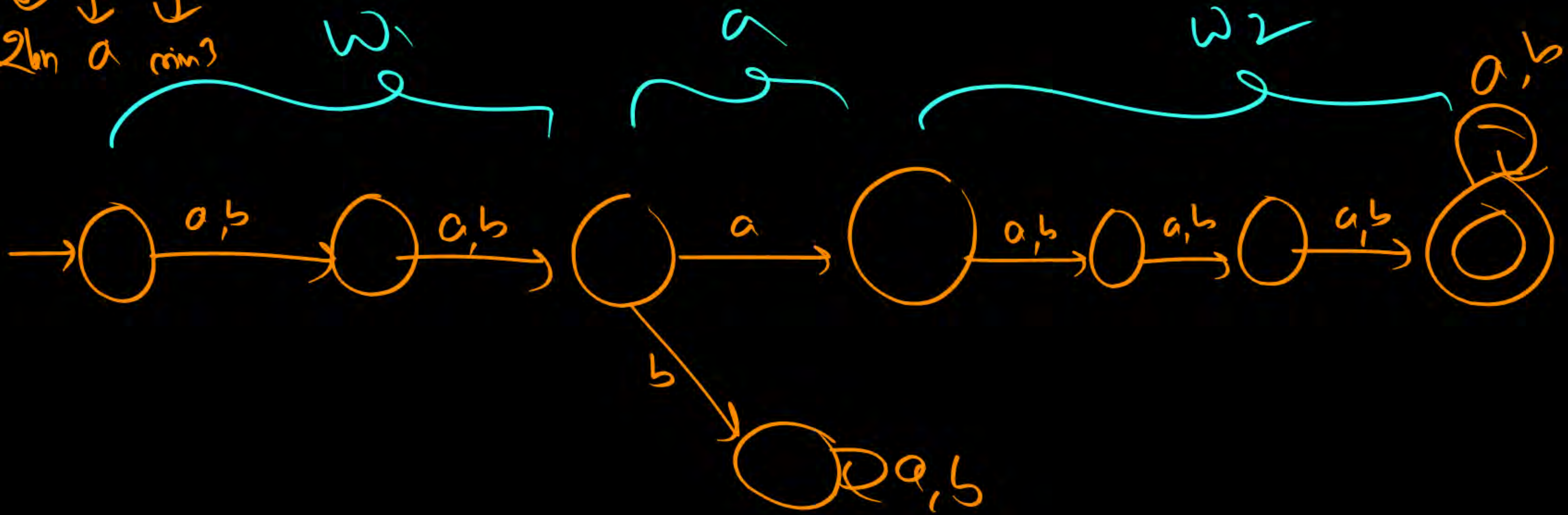
Consider the language L given by the regular expression $(a+b)^*b(a+b)$ over the alphabet $\{a, b\}$. The smallest number of states needed in a deterministic finite-state automaton (DFA) accepting L is 4.   **(GATE – 17 – SET1)**

k^{th} symbol from end is 'b'

2^k states

The minimum possible number of states of a deterministic finite automaton that accepts the regular language **(GATE – 17 – SET2)** $L=\{w_1aw_2 \mid w_1, w_2 \in \{a, b\}^*, |w_1| = 2, |w_2| \geq 3\}$ is ___8___.

2len a min3



The lexical analysis for a modern computer language such as java needs the power of which one of the following machine models in a necessary and sufficient sense? **(GATE - 11)**

(a) Finite state automata

(b) Deterministic pushdown automata

(c) Non –deterministic pushdown automata

(d) Turing machine

In Compiler,

FA, RegEx, Reg Grammar

To recognize tokens

Keywords
operators
Constants
Identifier,

The number of substrings (of all lengths inclusive) that can be formed from a character string of length n is **(GATE – 89 & 94)**

(a) ~~n~~

(b) ~~n^2~~

(c) ~~$\frac{n(n-1)}{2}$~~

(d) ~~$\frac{n(n+1)}{2}+1$~~

No option

$$n+1 \leq \text{No. of substrings} \leq \frac{n(n+1)}{2}+1$$

Consider the following language.

$L = \{x \in \{a, b\}^* \mid \text{number of } a\text{'s in } x \text{ divisible by 2 but not divisible by 3}\}$

The minimum number of states in DFA that accepts L is ___6___

\#a's/2

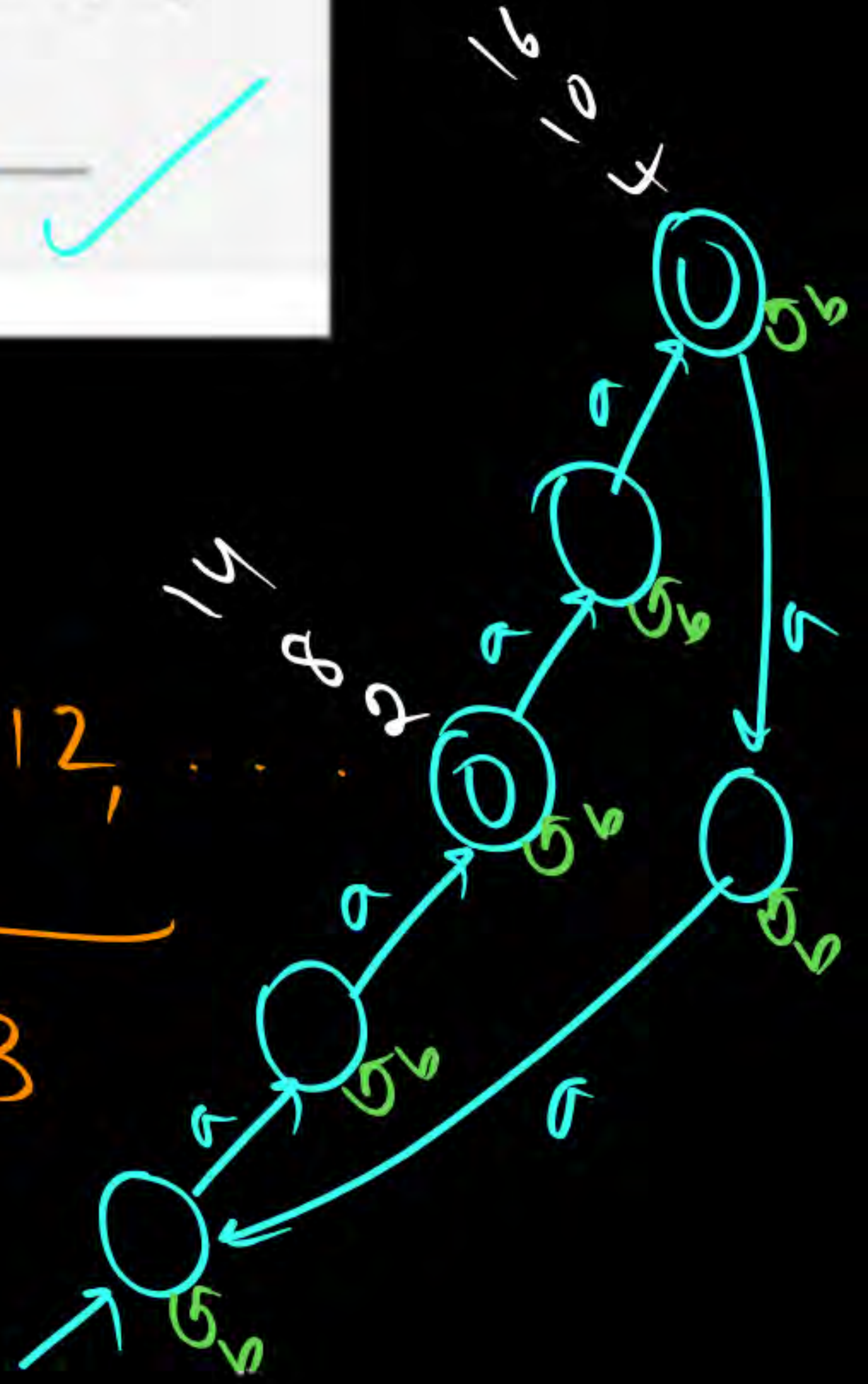
$\cancel{0}, 2, 4, \cancel{6}, 8, 10, \cancel{12}, 14, \ldots$

\#a's/3

$0, 3, 6, 9, 12, \ldots$

\#a's/2 but not div by 3

$2, 4, 8, 10, 14, 16, \ldots$

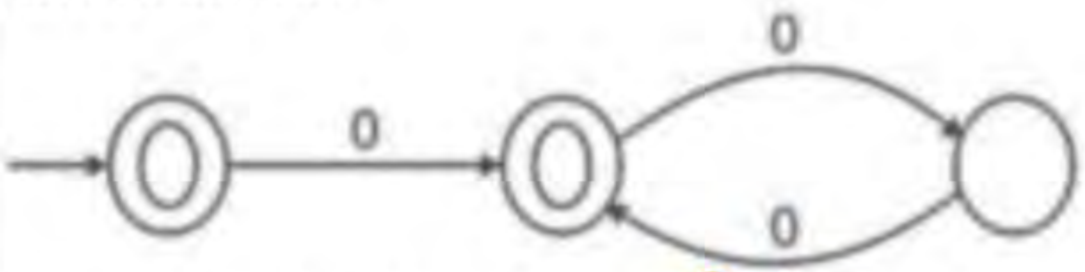


Given a language L, define L^i as follows:

$L^0 = \varepsilon$

$L^i = L^{i-1} \cdot L$ *For all* $i > 0$

The order of a language is defined as the smallest such that $L^k = L^{k+1}$. Consider the language L_1 (over alphabet 0) accepted by the following automaton:



The order of L_1 is ___2___

Algo & TOC

$L^0 =$ ✓

$L^1 = L^0 \Rightarrow O(L) = 0$

$L^2 = L^1 \Rightarrow O(L) = 1$

$L^3 = L^2 \Rightarrow O(L) = 2$

$L^4 = L^3 \Rightarrow O(L) = 3$

Note: If $L^k = L^{k-1}$
$\Rightarrow O(L) = 3$

$L = \varepsilon + 0(00)^*$

$L^3 = L^2 \cdot L$
$= 0^* \cdot L = 0^*$

$\boxed{L^3 = L^2}$

$L^0 = \varepsilon \longrightarrow$ ①

$L^1 = L^{1-1} \cdot L = L^0 \cdot L = L = \varepsilon + 0(00)^*$ → ②

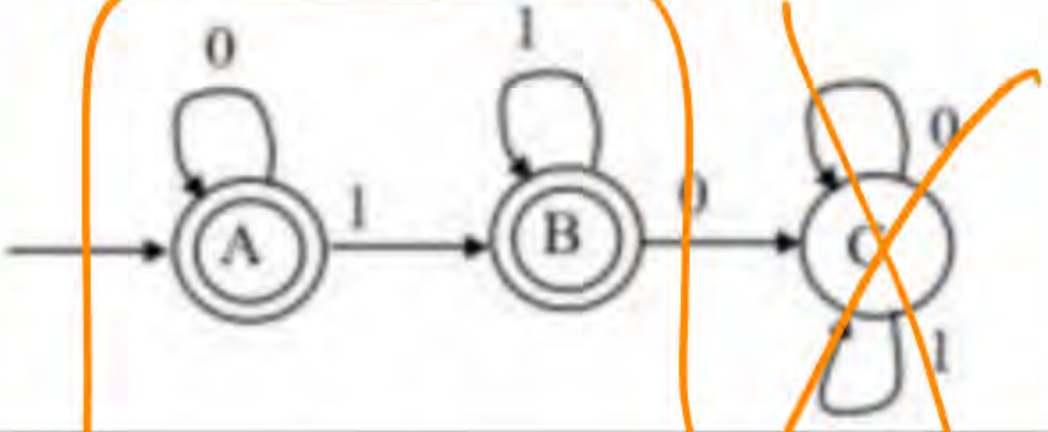
$\boxed{L^1 \neq L^0}$

$L^2 = L^1 \cdot L = (\varepsilon + 0(00)^*) \cdot (\varepsilon + 0(00)^*) = 0^*$

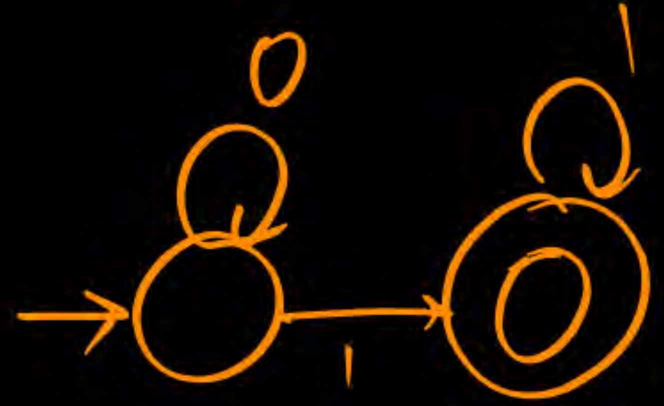
$\boxed{L^2 \neq L^1}$

$O(L) = K$ for smallest K, $L^K = L^{K+1}$

The regular expression for the language recognized by the finite state automation of the below figure is _____ **(GATE - 94)**



$L = 0^* 1^*$



$L = 0^* 1 1^* = 0^* 1^+$

$L = 0^*$

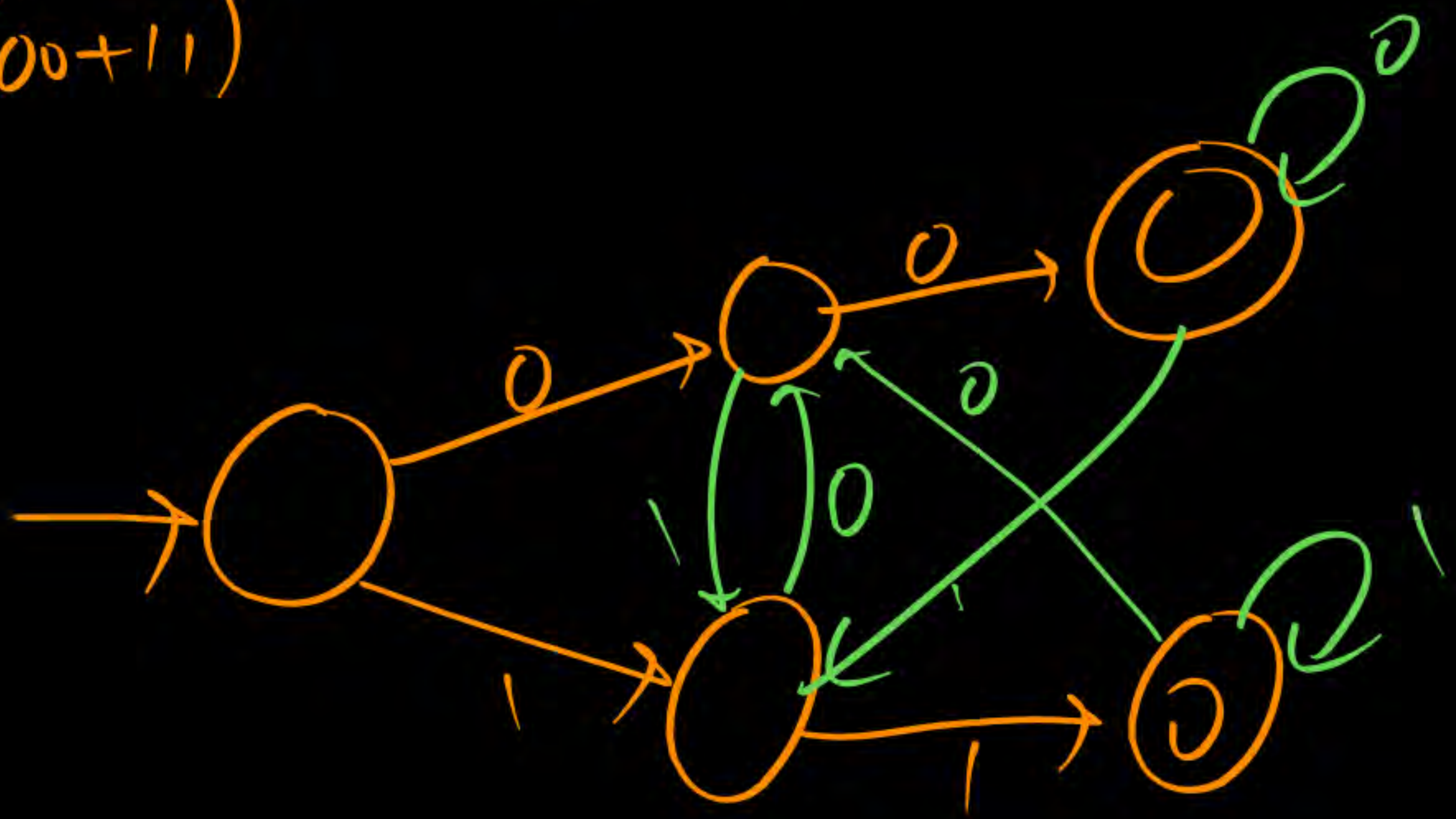
Let L be the set of all binary strings whose last two symbols are the same .The number of states in the minimum state deterministic finite-state automaton accepting L is

(GATE - 98)

$\Rightarrow$ 5 states

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

$L = (0+1)^*(00+11)$



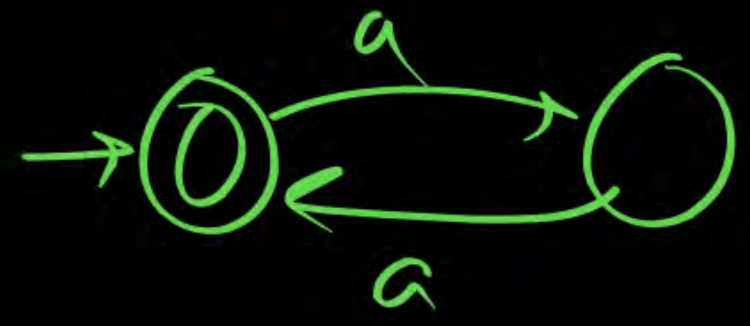
What can be said about a regular language L over {a} whose minimal finite state automaton has two states? **(GATE - 2000)**

(a) L must be $\{a^n \mid n \text{ is odd}\}$

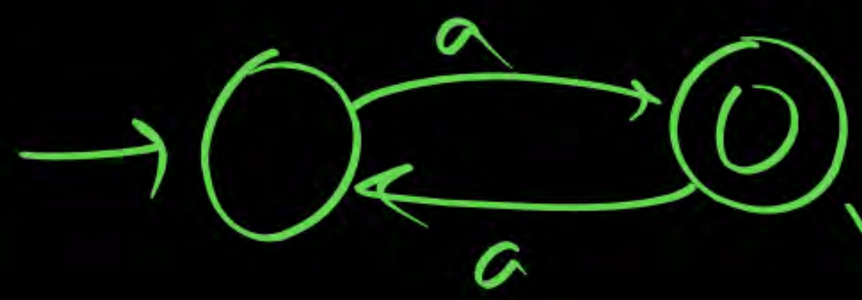
(b) L must be $\{a^n \mid n \text{ is even}\}$

(c) L must be $\{a^n \mid n \geq 0\}$

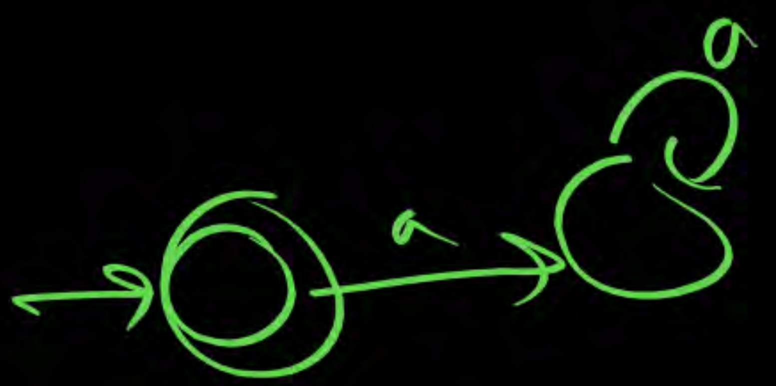
(d) Either L must be $\{a^n \mid n \text{ is odd}\}$ or L must be $\{a^n \mid n \text{ is even}\}$

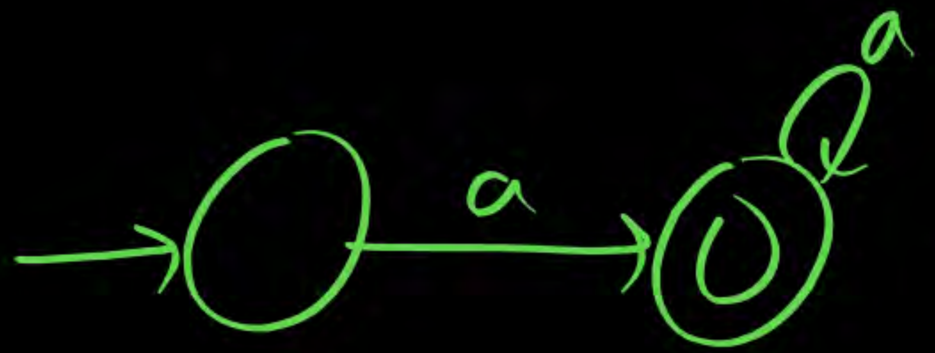


$L = (aa)^*$



$L = a(aa)^*$





$L = a^+$

Consider a DFA over $\sum = \{a, b\}$ accepting all strings which have number of a's divisible by 6 and number of b's divisible by 8. What is the minimum number of states that the DFA will have?

(GATE - 01)

(a) 8 (b) 14

(c) 15 (d) 48

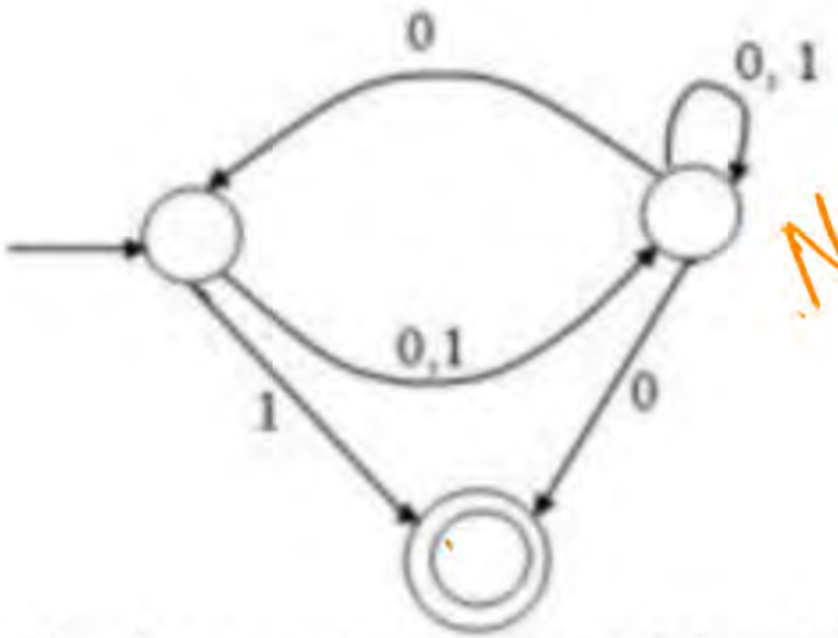
The smallest finite automation which accepts the language

$L = \{x \mid \text{length of } x \text{ is divisible by } 3\}$ has

(GATE - 02)

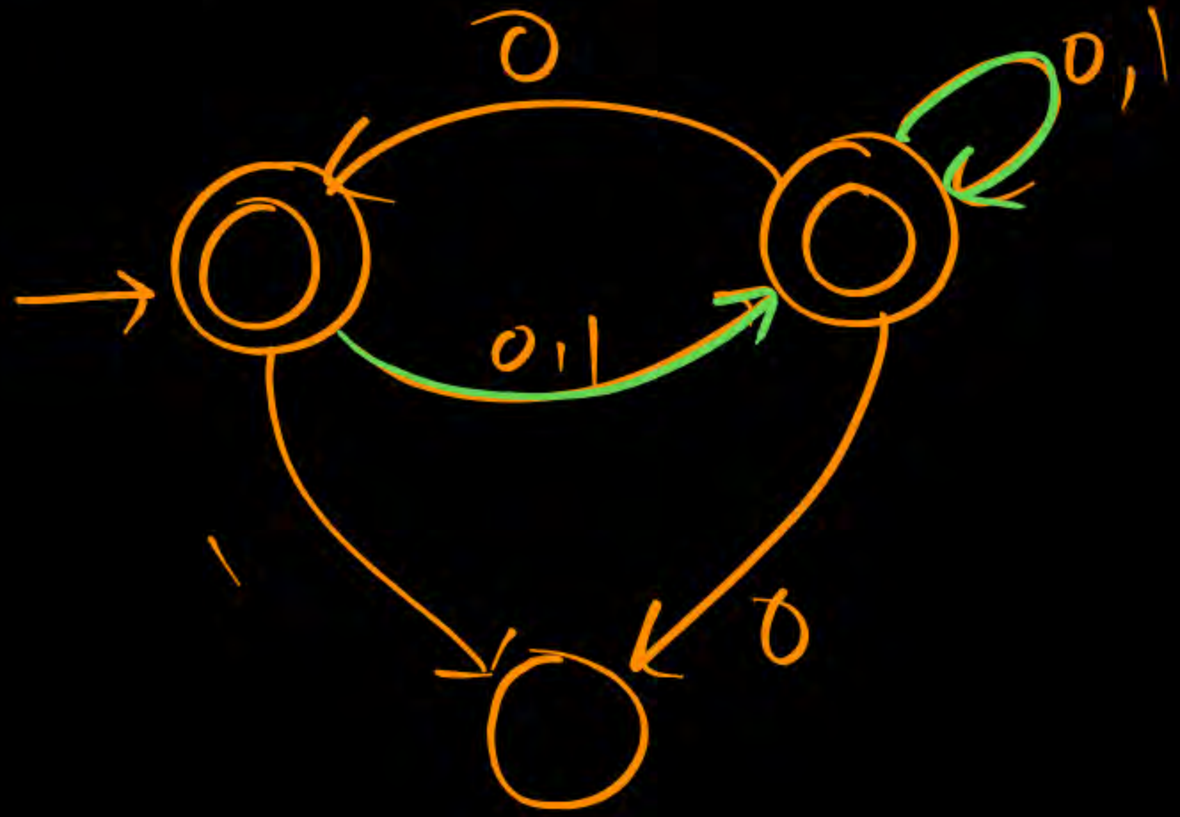
(a) 2 states
(b) 3 states
(c) 4 states
(d) 5states

Consider the NFA M shown below.



NFA $= L \subset \Sigma^*$

$L_1 = (0+1)^*$



Let the language accepted by M be L. Let L_1 be the language accepted by the NFA, M_1 obtained by changing the accepting state of M to a non-accepting state and by changing the non-accepting state of M to accepting states. Which of the following statements is true?

(a) $L_1 = \{0, 1\}^* - L$ ✗

(b) $L_1 = \{0, 1\}^*$ ✓

(c) $L_1 \subseteq L$ ✗

(d) $L_1 = L$ ✗

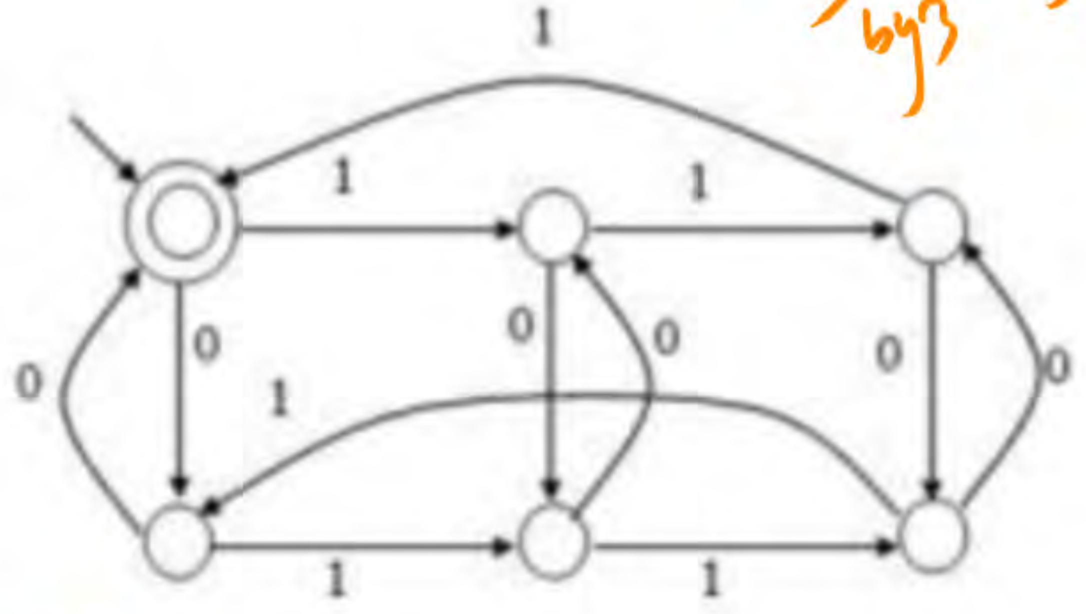
$L \subseteq L_1$ ✓

$L_1 \subseteq L$ ✗

The following finite state machine accepts all those binary strings in which the number of 1's and 0's are respectively

Div by 3 Div by 2

(GATE - 04)



(a) Divisible by 3 and 2

(b) Odd and even

(c) Even and odd

(d) Divisible by 2 and 3

Consider the machine M:

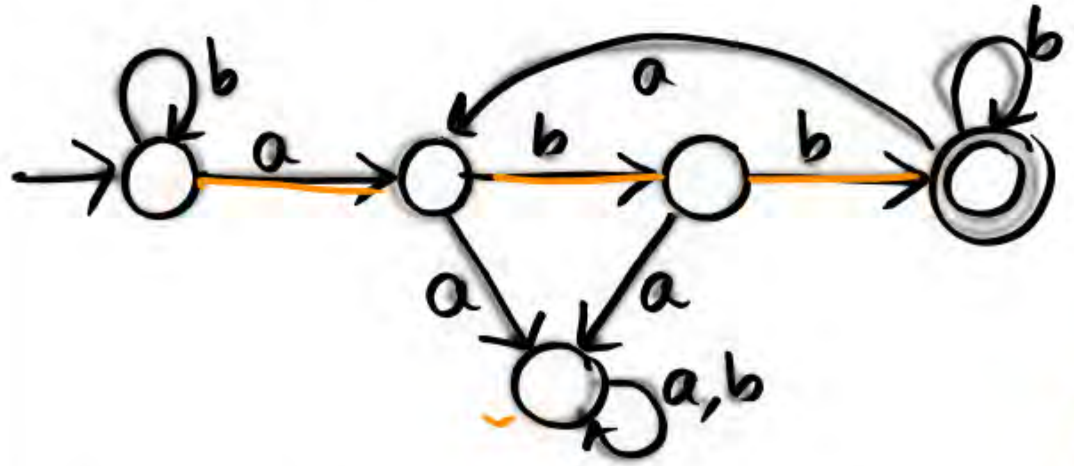


abb ✓

$\boxed{\text{abba}}$ ✗

The language recognized by M is:

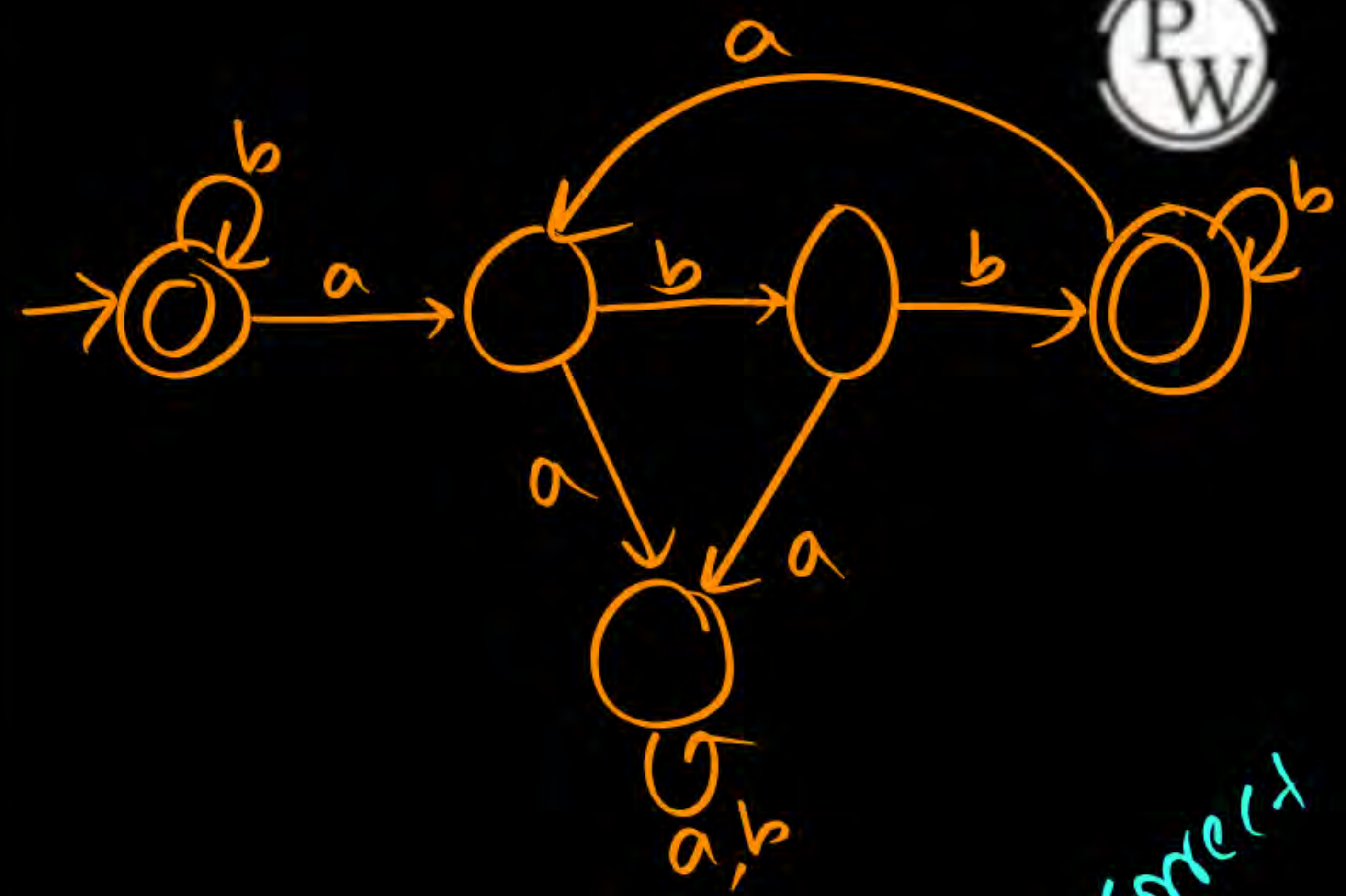
(GATE - 05)

(a) $\{w \in \{a,b\}^* \mid$ every a in w is followed by exactly two b's$\}$

(b) $\{w \in \{a,b\}^* \mid$ every a in w is followed by at least two b's$\}$

(c) $\{w \in \{a,b\}^* \mid$ w contains the substring 'abb'$\}$ = Set of all strings containing abb.

(d) $\{w \in \{a,b\}^* \mid$ w does not contain 'aa' as a substring$\}$



⇓

Option (b) is correct

If s is a string over $(0+1)^*$ then let $n_0(s)$ denote the number of 0's in s and $n_1(s)$ the number of 1's in s. Which one of the following languages is not regular? **(GATE - 06)**

2, 3, 5, 7

(a) $L = \{s \in (0+1)^* \mid n_0(s) \text{ is a 3-digit prime}\}$ ⇒ Reg

(b) $L = \{s \in (0+1)^* \mid \text{for every prefix } s' \text{ of } s, |n_0(s') - n_1(s')| \leq 2\}$ ⇒ Reg

(c) $L = \{s \in (0+1)^* \mid |n_0(s) - n_1(s)| \leq 4\}$ ⇒ Not reg

(d) $L = \{s \in (0+1)^* \mid n_0(s) \bmod 7 = n_1(s) \bmod 5 = 0\}$ ⇒ Reg

35 states

Consider the regular language

$L = (111+11111)^*$. The minimum number of states in any DFA accepting this language is

(GATE - 06)

(a) 3 (b) 5 (c) 8 (d) 9

$(1^3+1^5)^* = \{\varepsilon, 1^3, 1^5, 1^6, \boxed{1^8}, 1^9, 1^{10}, \ldots\}$

9 state

A minimum state deterministic finite automaton accepting the language

$L = \{w \mid w \in \{0, 1\}^*$, number of 0's and 1's in w are divisible by 3 and 5, respectively$\}$ has **(GATE - 07)**

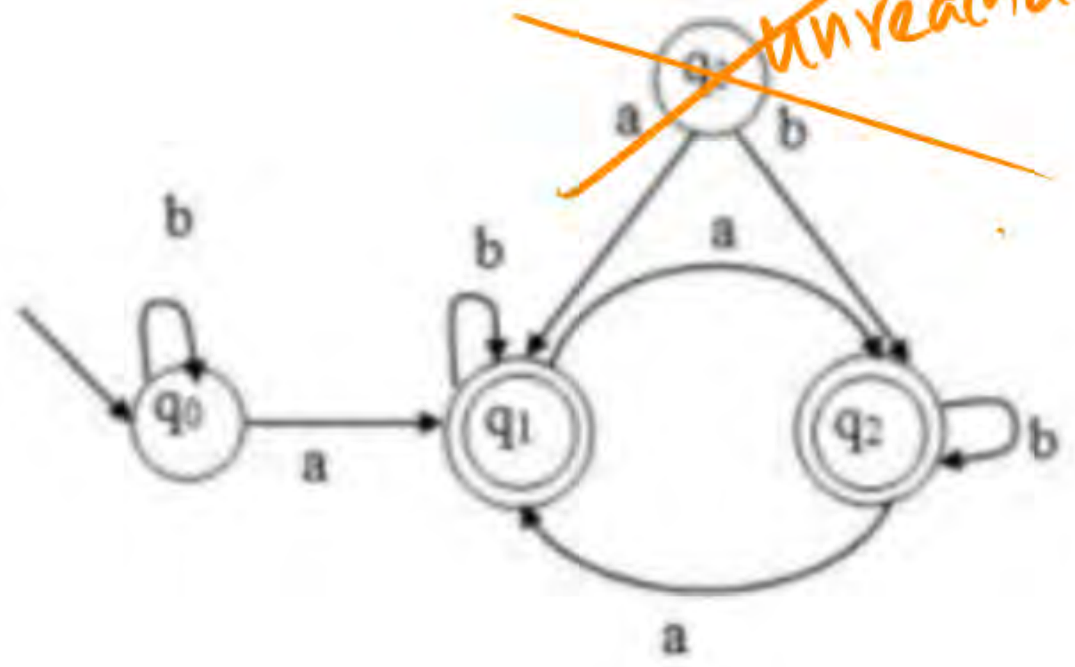
(a) 15 states (b) 11 states

(c) 10 states (d) 9 states

$3 \times 5 = 15$

Consider the following finite state automaton

(GATE - 07)



Unreachable

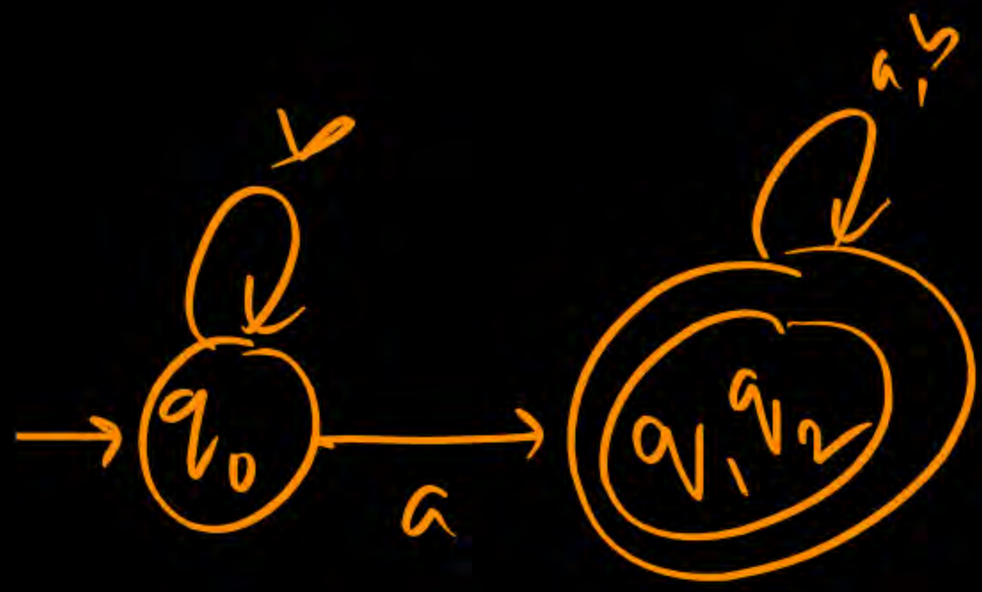
The language accepted by this automaton is given by the regular expression

(a) $b^*ab^*ab^*ab^*$ $\rightarrow n_a = 3$

(b) $(a+b)^*$

(c) $b^*a(a+b)^*$

(d) $b^*ab^*ab^*$ $\rightarrow n_a = 2$

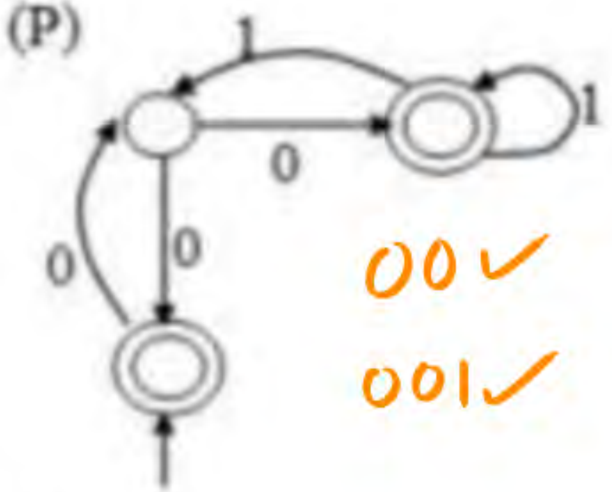


$b^*a(a+b)^*$

$(a+b)^*a(a+b)^*$

Match the following NFAs with the regular expressions they correspond to

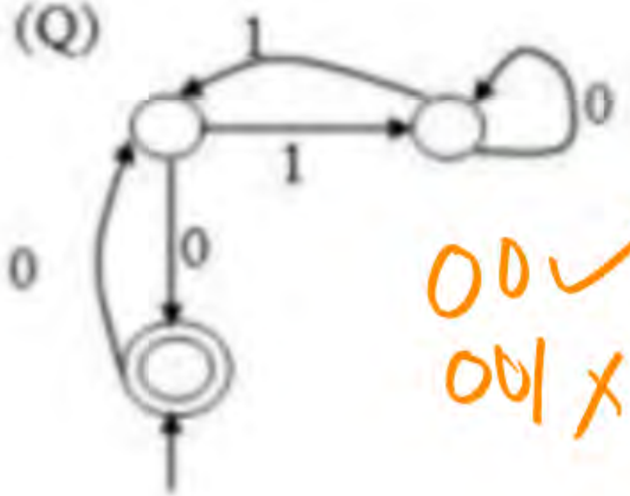
(P)



00 ✓

001 ✓

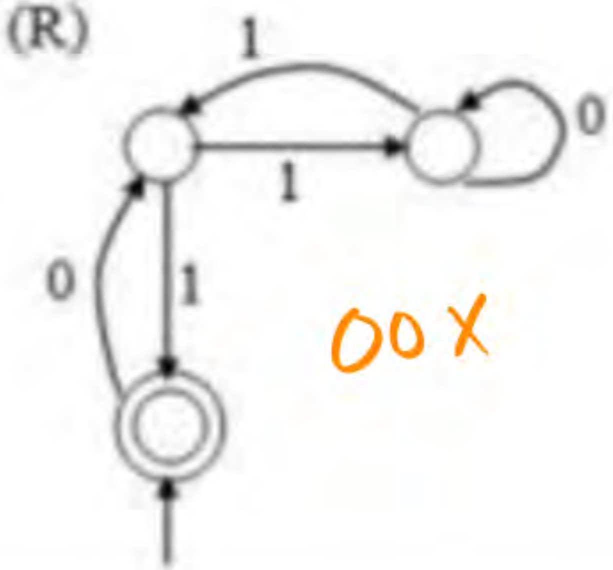
(Q)



00 ✓

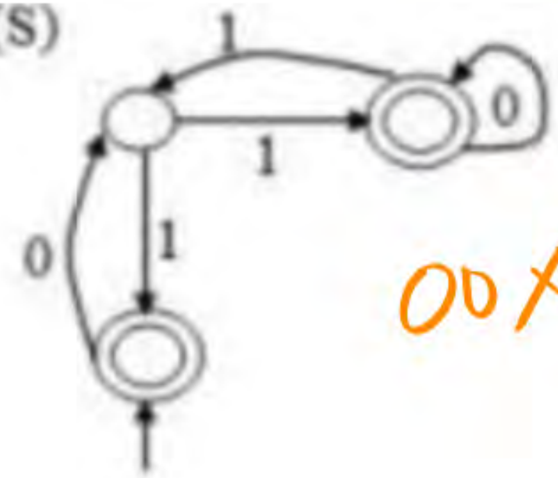
001 ✗

(R)



00 ✗

(S)



00 ✗

(GATE - 08)

1. $\varepsilon + 0(01^*1 + 00)^*01^*$ → 001 ✓, 00 ✓ → P
2. $\varepsilon + 0(10^*1 + 00)^*0$ → Q
3. $\varepsilon + 0(10^*1 + 10)^*1$ → 00 ✗
4. $\varepsilon + 0(10^*1 + 10)^*10^*$

P, Q

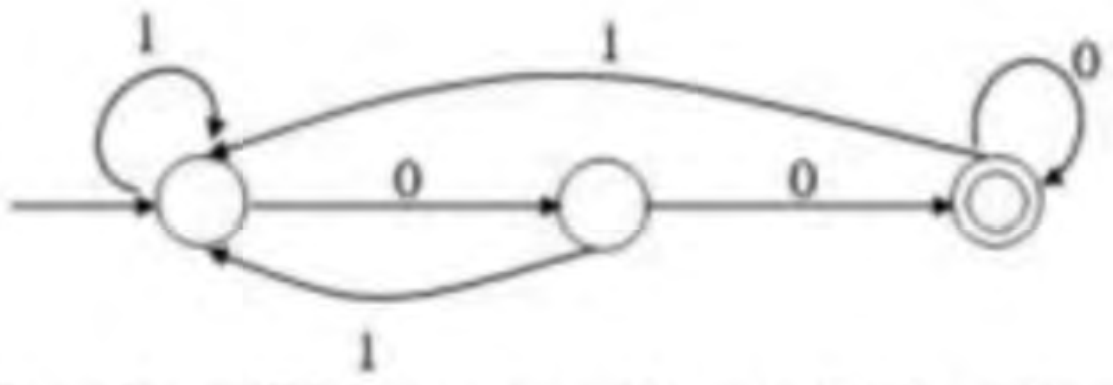
R, S

(a) P-2, Q-1, R-3, S-4

(b) P-1, Q-3, R-2, S-4

(c) $\boxed{\text{P-1, Q-2,}}$ R-3, S-4

(d) P-3, Q-2, R-1, S-4



The above DFA accepts the set of all strings over {0, 1} that

(GATE - 09)

(a) Begins either with 0 or 1

(b) End with 0

(c) End with 00

(d) Contains the substring 00.

Let L={w∈$(0+1)^*$|w has even number of 1's}, i.e L is the set of all bit strings with $\boxed{\text{even number of 1's.}}$ Which one of the regular expressions below represents L?

(GATE - 10)

(a) $(0^*10^*1)^*$ → 0

(b) $0^*\ (10^*10^*)^*$

(c) $0^*\ (10^*1)^*0^*$

(d) $0^*\ 1(10^*1)^*10^*$ → ε

$\underbrace{11011}_{0}$

11011

$(1 0^0 1 0^1)(1 0^0 1 0^0)$

$(1 \varepsilon 1 0)(1 \varepsilon 1 \varepsilon)$

11011

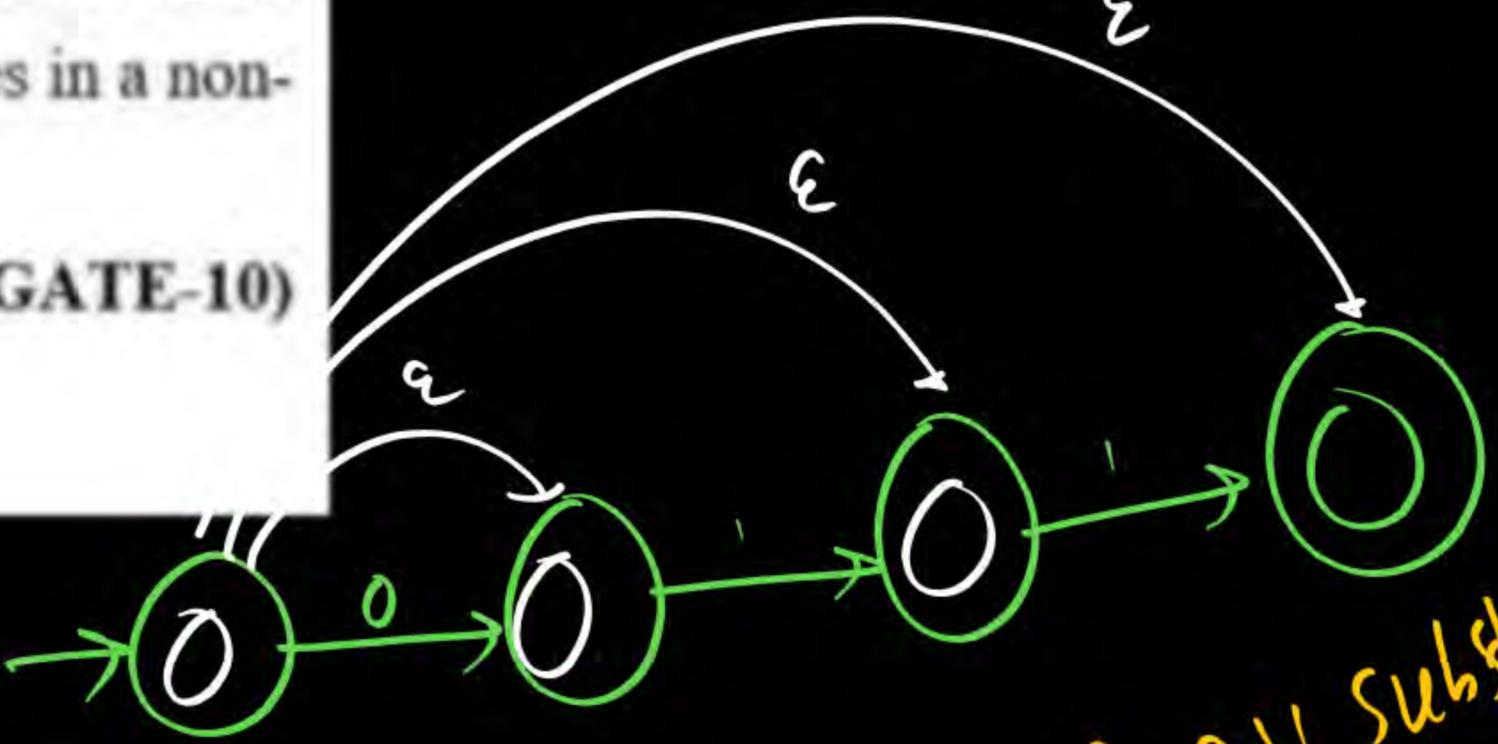
$$0^*\ (0^*1\ 0^*\ 1 0^*)^*\ 0^*$$

Let w be any string of length n in $\{0, 1\}^*$. Let L be the set of all substrings of w. What is the minimum number of states in a non-deterministic finite automation that accepts L?

(GATE-10)

(a) $n - 1$ (b) n

(c) $n+1$ (d) 2^{n-1}



$w = \underbrace{011}_{n=3}$

$L = \{\varepsilon, 0, 1, 01, 11, 011\}$ = Set of all substrings of w

n+1 states

Definition of the language L with alphabet {a} is given as following.

$L=\{a^{nk} \mid k>0$, and n is a positive integer constant$\}$

What is the minimum number of states needed in a DFA to recognize L?

(GATE - 11)

(a) $k+1$

(b) $n+1$

(c) 2^{n+1}

(d) 2^{k+1}

$n = \text{constant}$

$k>0$

$L=\{a^{nk} \mid k>0\}$

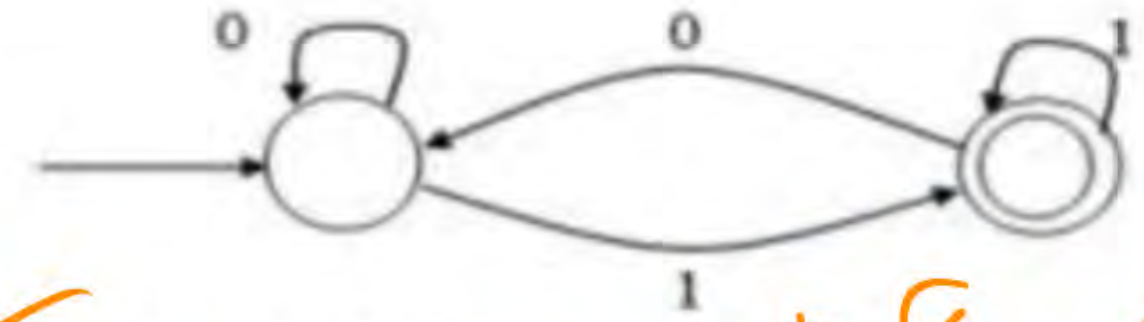
$n=1 \Rightarrow \{a^k \mid k>0\} = a^+ \Rightarrow$ 2 states

$n=2 \Rightarrow \{a^{2k} \mid k>0\} = (aa)^+ \Rightarrow$

$\Rightarrow$ 3 states

Which of the regular expression given below represent the following DFA?

(GATE – 14-SET1)



Ends with 1

I. 0*1(1+00*1)* $\rightarrow$ $0^*1[(\underline{\varepsilon+00^*})1]^*$

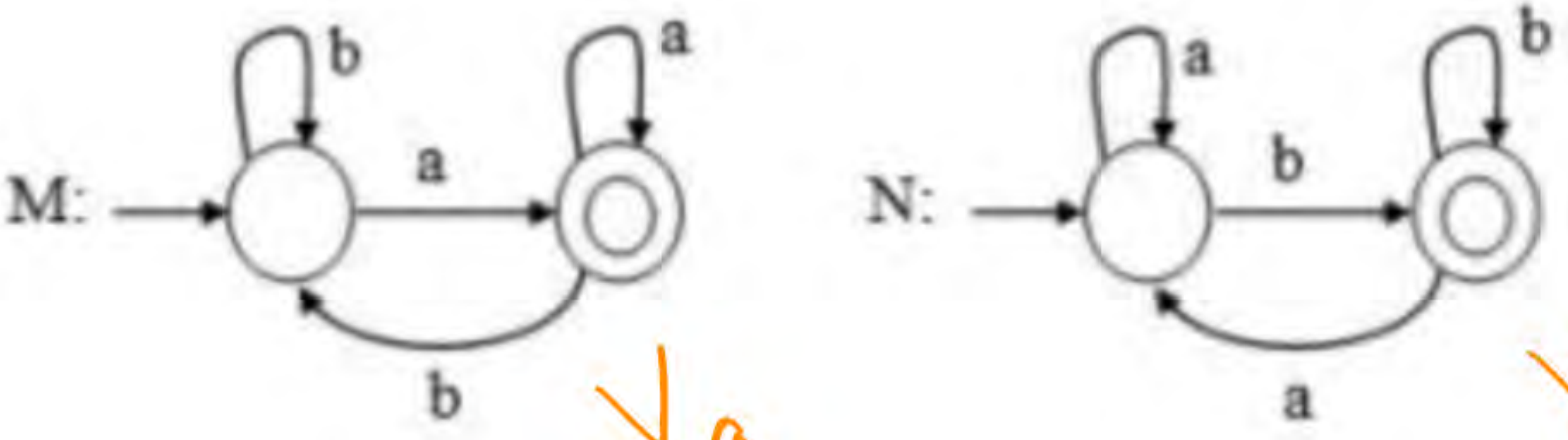
$0^*1[0^*1]^* = \underline{(0^*1)^+}$

II. 0*1*$\boxed{1}$+11*0*$\boxed{1}$

III. (0+1)*1

(a) I and II only ~~(b)~~ I and III only

(c) II and III only (d) I, II, and III



X_a X_b

Consider the DFAs M and N given above. The number of states in a minimal DFA that accepts the languages $L(M) \cap L(N)$ is ___1___. **(GATE – 15 – SET1)**

$$\frac{X_a \cap X_b}{\phi}$$

Consider the alphabet $\Sigma = \{0, 1\}$, the null/empty string λ and the set of strings X_0, X_1, and X_2 generated by the corresponding non-terminals of a regular grammar X_0, X_1, and X_2 are related as follows.

$$X_0 = 1\,X_1$$
$$X_1 = 0\,X_1 + 1\,X_2$$
$$X_2 = 0\,X_1 + \{\lambda\}$$

Which one of the following choices precisely represents the strings in X_0?

(GATE – 15- SET2)

(a) $10(0^*+(10)^*)1$

(b) $10(0^*+(10^*))^*1$

(c) $1(0+10)^*1$

(d) $10(0+10)^*1+110(0+10)^*1$

$X_0 \rightarrow 1X_1$

$X_1 \rightarrow 0X_1 \mid 1X_2$

$X_2 \rightarrow 0X_1 \mid \epsilon$

$\boxed{X_2 = 0X_1 + \varepsilon} \rightarrow 1$

$X_1 \rightarrow \boxed{0}X_1 \mid \boxed{10}X_1 \mid 1$

$X_1 = (0+10)^*1$

$X_0 = 1(0+10)^*1$

$X_0 = ?$

Let δ denote the transition function and $\hat{\delta}$ denote the extended transition function of the ε–NFA whose transition table is give below:

δ	ε	a	b
$\rightarrow q_0$	$\{q_2\}$	$\{q_1\}$	$\{q_0\}$
q_1	$\{q_2\}$	$\{q_2\}$	$\{q_3\}$
q_2	$\{q_0\}$	ϕ	ϕ
q_3	ϕ	ϕ	$\{q_2\}$

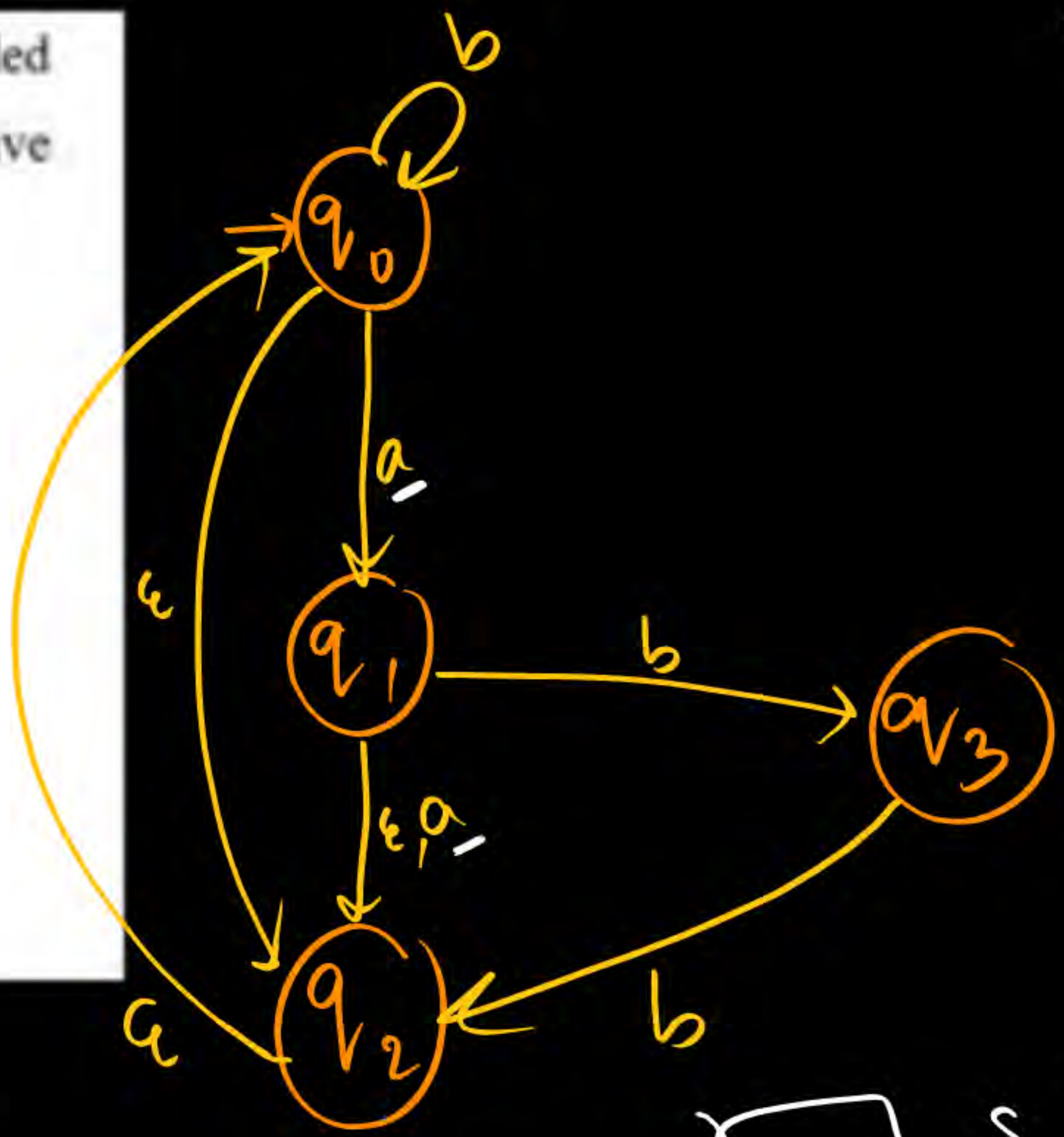
Then $\hat{\delta}(q_2, aba)$ is (GATE – 17 – SET2)

(a) ϕ

(b) $\{q_0, q_1, q_3\}$

(c) $\{q_0, q_1, q_2\}$

(d) $\{q_0, q_2, q_3\}$



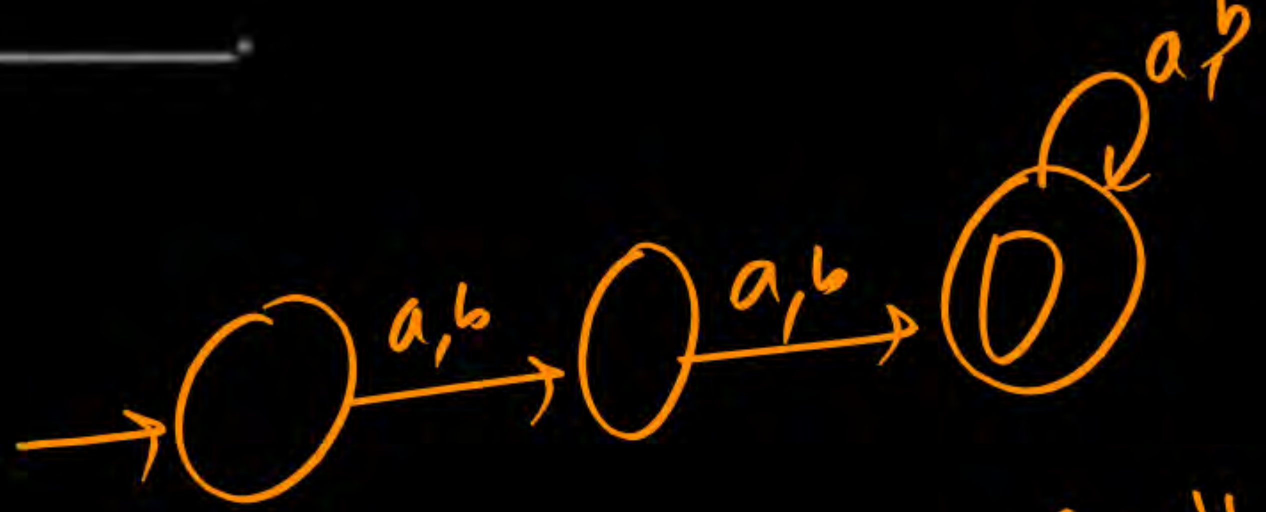
$$q_2 \xrightarrow{aba} q$$

$$q_2 \xrightarrow{\varepsilon} q_0 \xrightarrow{a} q_1 \xrightarrow{b} q_3 \times$$

$$q_1 \xrightarrow{\varepsilon} q_2 \xrightarrow{\varepsilon} q_0 \xrightarrow{b} q_0 \xrightarrow{a} \boxed{q_1} \xrightarrow{\varepsilon} \boxed{q_2} \xrightarrow{\varepsilon} \boxed{q_0}$$

Let L= $(a+b)(a+b)(a + b)^*$ over alphabet $\Sigma = \{a, b\}$. **[NAT]**

If x is total number of final states and y is total number of non-final states, then $|x-y|$ = ________.



$x = 1$ = no. of final

$y = 2$ = no. of nonfinal

$|x-y| = |1-2| = 1$

If x and y are number of equivalence classes for L1 and L2 respectively then L1+L2 = _____0.

L1 = aa(a+b)*
L2 = (a+b)* aa

GATE 1998

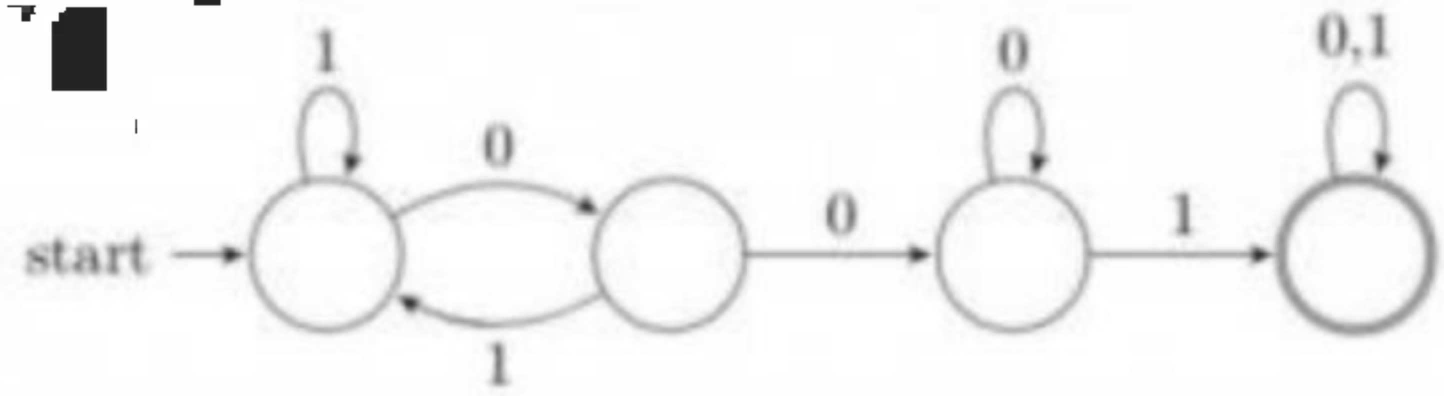
Which of the following set can be recognized by a Deterministic Finite state Automaton?

A. The numbers $1,2,4,8,\ldots 2^n,\ldots$ written in binary
B. The numbers $1,2,4,8,\ldots 2^n,\ldots$ written in unary
C. The set of binary string in which the number of zeros is the same as the number of ones.
D. The set $\{1,101,11011,1110111,\ldots\}$

Consider a DFA over $\Sigma=\{a,b\}$ accepting all strings which have number of a's divisible by 6 and number of b's divisible by 8. What is the minimum number of states that the DFA will have?

A. 8
B. 14
C. 15
D. 48

Consider the following deterministic finite state automaton M.



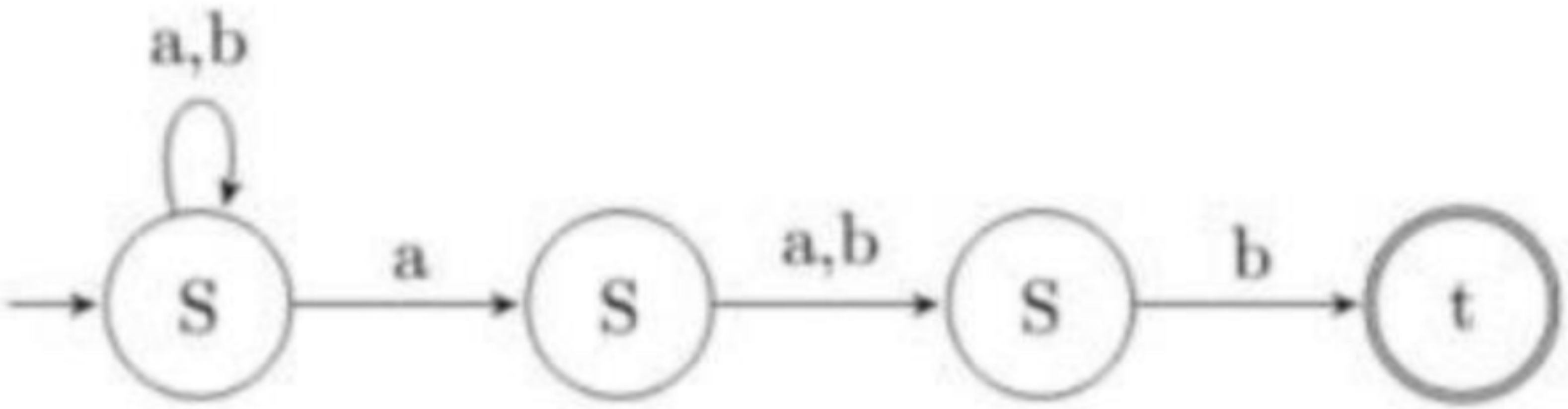
Let S denote the set of seven bit binary strings in which the first, the fourth, and the last bits are 1. The number of strings in S that are accepted by M is

A. 1
B. 5
C. 7
D. 8

Which one of the following regular expressions is NOT equivalent to the regular expression $(a+b+c)^*$?

A. $(a^*+b^*+c^*)^*$
B. $(a^*b^*c^*)^*$
C. $((ab)^*+c^*)^*$
D. $(a^*b^*+c^*)^*$

Which regular expression best describes the language accepted by the non-deterministic automaton below?



A. $(a+b)^* a(a+b)b$

B. $(abb)^*$

C. $(a+b)^* a(a+b)^* b(a+b)^*$

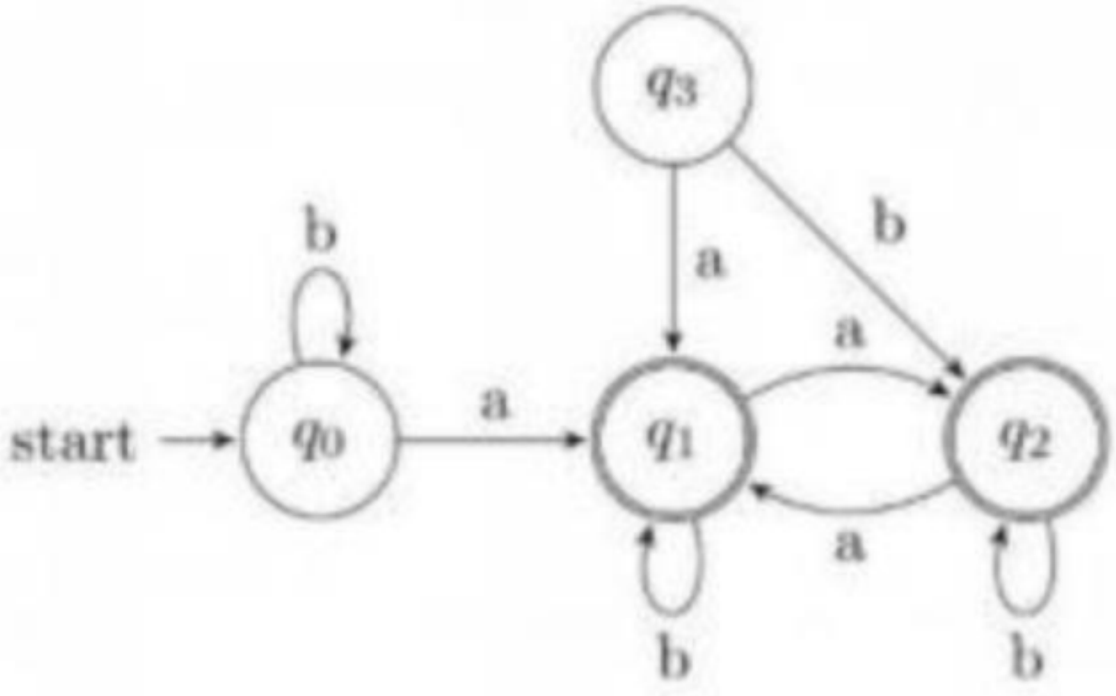
D. $(a+b)^*$

A minimum state deterministic finite automaton accepting the language

$L=\{w|w\in\{0,1\}^*$, number of 0s and 1s in w are divisible by 3 and 5, respectively $\}\}$ has

A. 15 states
B. 11 states
C. 10 states
D. 9 states

Consider the following Finite State Automaton:



The language accepted by this automaton is given by the regular expression

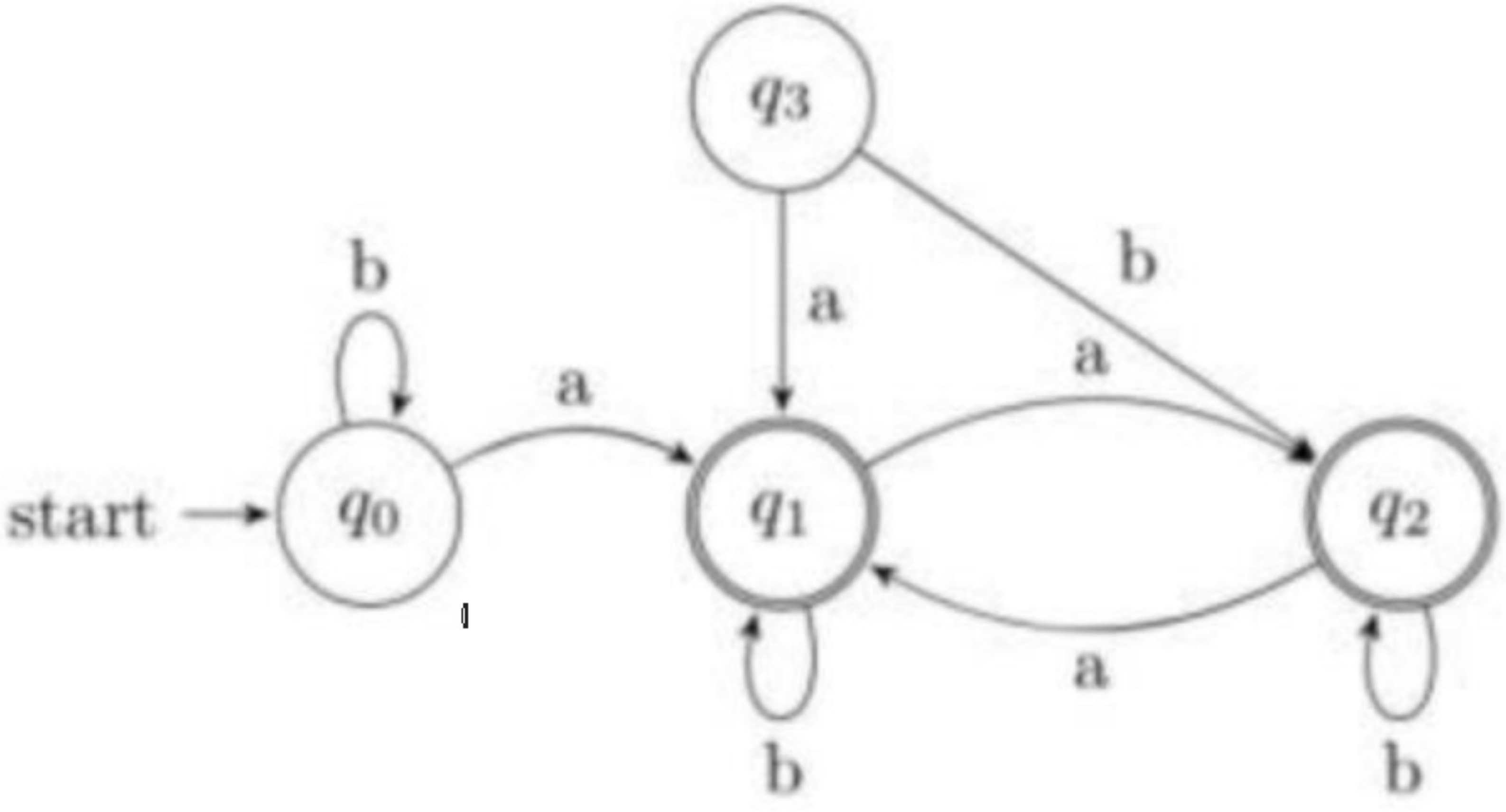
A. b*ab*ab*ab*

B. (a+b)*

C. b*a(a+b)*

D. b*ab*ab*

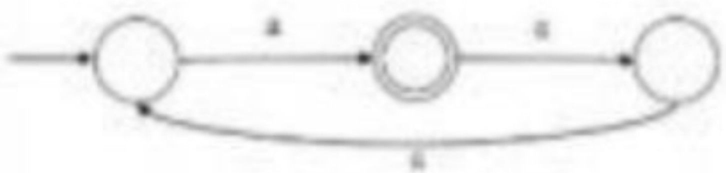
Consider the following Finite State Automaton:



The minimum state automaton equivalent to the above FSA has the following number of states:

A. 1
B. 2
C. 3
D. 4

What is the complement of the language accepted by the NFA shown below? Assume $\Sigma = \{a\}$ and ϵ is the empty string.

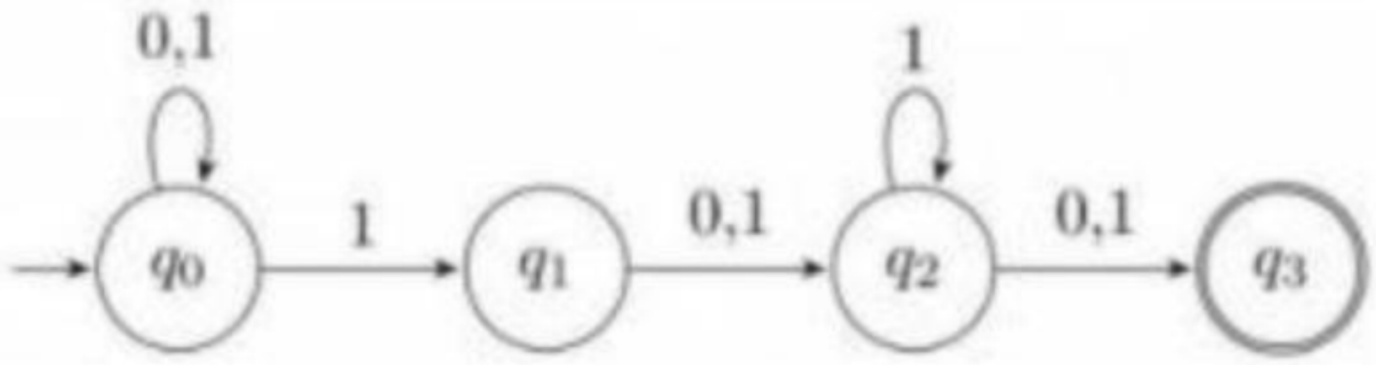


A. ϕ

B. $\{\epsilon\}$

C. a^*

D. $\{a, \epsilon\}$



What is the set of reachable states for the input string 0011?

A. {q0,q1,q2}
B. {q0,q1}
C. {q0,q1,q2,q3}
D. {q3}

The number of states in the minimal deterministic finite automaton corresponding to the regular expression $(0+1)^*(10)$ is _____.

The number of states in the minimum sized DFA that accepts the language defined by the regular expression.

$(0+1)^*(0+1)(0+1)^*$ is ________.

Let Σ be the set of all bijections from $\{1, \dots, 5\}$ to $\{1, \dots, 5\}$, where id denotes the identity function, i.e. $id(j) = j, \forall j$. Let $\circ$ denote composition on functions. For a string $x = x_1 x_2 \cdots x_n \in \Sigma^n$, $n \geq 0$, let $\pi(x) = x_1 \circ x_2 \circ \cdots \circ x_n$.

Consider the language $L = \{x \in \Sigma^* \mid \pi(x) = id\}$. The minimum number of states in any DFA accepting L is ______.

maths & TOC

Bijective function?

Identity function?


THANK YOU
GW
SOLDIERS !