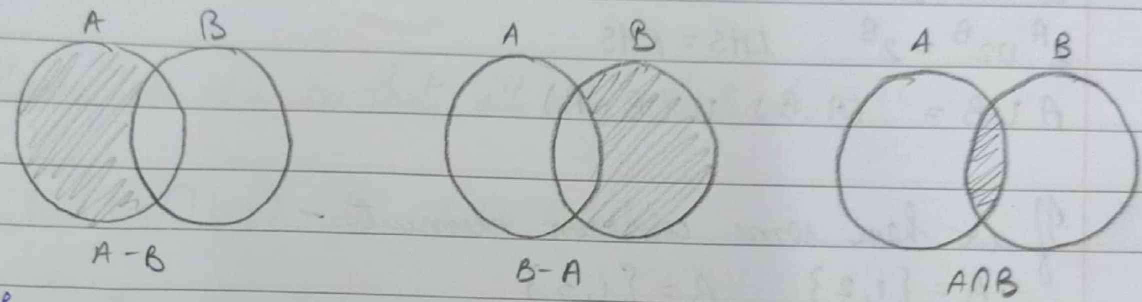
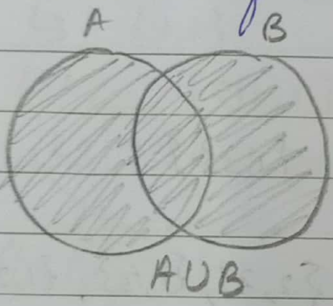
TUTORIAL - 1

1.



Thus union of all three is $A \cup B$



2. $P \vee \sim(P \to Q)$

P	Q	$P \to Q$	$\sim(P \to Q)$	$P \vee \sim(P \to Q)$
0	0	1	0	0
0	1	1	0	0
1	0	0	1	1
1	1	1	0	1

Hence, Simple statement $= P$

3. Relation b/w $2^{A \cup B}$ and $2^A \cup 2^B$

$$2^{A \cup B} = \frac{2^A \cup 2^B}{2^{(A \cap B)}}$$

Suppose $A = \{1\}$, $B = \{2\}$

$2^A = \{\phi, \{1\}\}$ $\quad 2^{A \cup B} = \{\phi, \{1\}, \{2\}, \{1, 2\}\}$

$2^B = \{\phi, \{2\}\}$

$2^A \cup 2^B = \{\phi, \{1\}, \{2\}\}$

$2^A \cup 2^B \subseteq 2^{A \cup B}$

- $A \subseteq B$ Hence let $A = \{1\}$, $B = \{1, 2\}$

Hence
$2^A = \{\phi, \{1\}\}$
$2^B = \{\phi, \{1\}, \{2\}, \{1,2\}\}$
$2^{A \cup B} = 2^B$
$2^A \cup 2^B = 2^B$ LHS = RHS
$A \cup B = (A-B) \cup (B-A)$

If we have some common elements –
$A = \{1,2\}$ $B = \{1,3\}$
$2^A = \{\phi, \{1\}, \{2\}, \{1,2\}\}$
$2^B = \{\phi, \{1\}, \{3\}, \{1,3\}\}$

$2^A \cup 2^B = \{\phi, \{1\}, \{2\}, \{3\}, \{1,2\}, \{1,3\}\}$

$2^{A \cup B} = \{\phi, \{1\}, \{2\}, \{3\}, \{1,2\}, \{2,3\}, \{1,3\}, \{1,2,3\}\}$
$2^A \cup 2^B \subseteq 2^{A \cup B}$

4. $L^* = (L^*)^* = (L^+)^* = (L^*)^+$
$L^* = \bigcup_{i=0}^{\infty} L^i$

$L^+ = \bigcup_{i=1}^{\infty} L^i$

$(L^*)^* = (\bigcup_{i=0}^{\infty} L^i)^* = \bigcup_{i=0}^{\infty} L^i$

$(L^*)^+ = (\bigcup_{i=0}^{\infty} L^i)^+ = \bigcup_{i=0}^{\infty} L^i$

$(L^+)^* = (\bigcup_{i=1}^{\infty} L^i)^* = \bigcup_{i=0}^{\infty} L^i$

Let L = string with length 2
$L = \{01, 00, 11, 10\}$

$L^* = \{0101, 01, 0011, 1000, \Lambda, \ldots\}$

$(L^*)^* = \{01, 0011, 0101, \Lambda \ldots\}$

$(L^+)^* = \{01, \Lambda, 00, \ldots\}$

$(L^*)^+ = \{0101, 01, 00, \Lambda, \ldots\}$

Hence we can see that all are identical.

5. $L_1(L_2 \cap L_3)$ & $L_1L_2 \cap L_1L_3$

→ $L_1 = \{01, 1\}$ $L_2 = \{1\}$

$L_3 = \{11, 1\}$

$L_1L_2 = \{011, 11\}$

$L_1L_3 = \{0111, 011, 111, 11\}$

$(L_2 \cap L_3) = \{1\}$ $L_1L_2 \cap L_1L_3 = \{011, 11\}$

$L_1(L_2 \cap L_3) = \{011, 11\}$ $\therefore L_1(L_2 \cap L_3) = L_1L_2 \cap L_1L_3$

Exception

$L_1 = \{01, 1\}$, $L_2 = \{1\}$, $L_3 = \{11\}$

$L_1L_2 \cap L_1L_3$ will be ϕ $\therefore$ Ans will be $\neq$.

M T W T F S S
Page No.:
Date:
YOUVA

6. $\sum_{i=1}^{n} i^2 = n(n+1)(2n+1)/6$

for $k \Rightarrow \frac{k(k+1)(2k+1)}{6}$

for $(k+1) \Rightarrow \frac{(k+1)(k+2)(2k+3)}{6}$

$$(1^2+2^2+3^2+\dots k^2+(k+1)^2 = \frac{k(k+1)(2k+1)}{6} + (k+1)^2$$

$$= \frac{k(k+1)(2k+1) + 6(k+1)^2}{6}$$

$$= \frac{(k+1)(2k^2+7k+6)}{6}$$

$$= \frac{(k+1)(k+2)(2k+3)}{6}$$

Thus we can say that

$$\Sigma i^2 = \frac{n(n+1)(2n+1)}{6}$$

7. $|x^2| = |x|$

Scanned with CamScanner

8. a. Set N of all natural numbers.

Step 1 : $1 \in N$

Step 2 : for every $x \in N$, $x+1 \in N$

Step 3 : No other string in N

b. Set S of all integer divisible by 7.

Step 1 : $0 \in L$

Step 2 : $x \in L$, $x+7 \in L$ & $x-7 \in L$

Step 3 : No other string in S.

c. Set U of all strings in $\{0,1\}^*$ containing substring 00.

Step 1 : $00 \in U$

Step 2 : $x \in U$, $0x \in U$ & $1x \in U$ and $x0 \in U$ and $x1 \in U$

Step 3 : No other string in U.

Tutorial - 2

Q1.

a. $b^* (ab)^* a^* \rightarrow$ aab $\notin$ RE
abb~~a~~ $\notin$ RE

b. $(a^* + b^*)(a^* + b^*)(a^* + b^*) \rightarrow$ abab $\notin$ RE
baba $\notin$ RE

c. $a^* (baa^*)^* b^* \rightarrow$ bba $\notin$ RE

d. $b^* (a + ba)^* b^* \rightarrow$ abba $\notin$ RE

e. $(a + ab)^* b^* \rightarrow$ ba, abba $\notin$ RE

f. $(a^* b^* a^* b^*) \rightarrow$ baba $\notin$ RE.

g. $(a + ba)^* b \rightarrow \wedge, a \notin$ RE

Q2. $r = a^* + b^*$

$s = ab^* + ba^* + b^* a + (a^* b)^*$

a. r but not s = aaa

b. s but not in r = ab

c. in both r and s = a, b, $\wedge$

d. not in r and s = baba, aba

Q3.

1. $(a+b)^* aa (a+b)^*$ atleast two consecutive a, $b^* ab^* ab^*$ exact two a's.
2. $b^* ab^* a (a+b)^*$ atleast 2 a's.
3. Null + $(a+b)^* (a+bb)$ ending should not be ab
4. $(aa + bb)(a+b)^* + (a+b)^* (aa+bb)$ starts from aa or bb. or ends
5. $(b + ab)^* (a + \wedge)$ no consecutive a in the string. or $(\wedge + a)(ba + b)^*$
6. For even length $[(a+b)^2]^*$, odd length $(a+b)((a+b)^2)^*$

7. ~~any number~~ maximum 6 or less $= (a+b+\wedge)^6$

minimum 6 or more $= (a+b)^6 (a+b)^*$

8. $\Sigma = \{0,1\} \Rightarrow$ strings having odd number of 1's.

Ans:

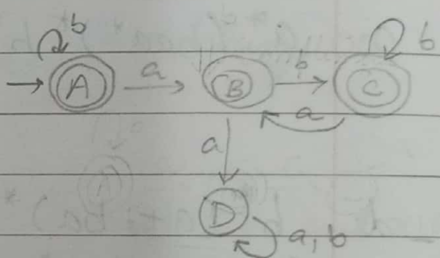
$$0^*1(0^*10^*1)^*0^* + 0^*(10^*10^*)^*10^*$$

Even no. of 0's.

Ans:

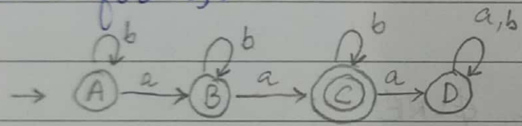
$$(1^*01^*01^*)^*$$

5.



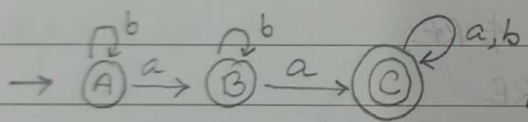
F.A. for Q3

1.



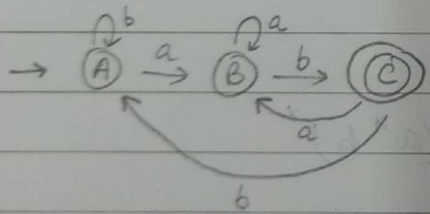
Exactly 2 aa.

2.



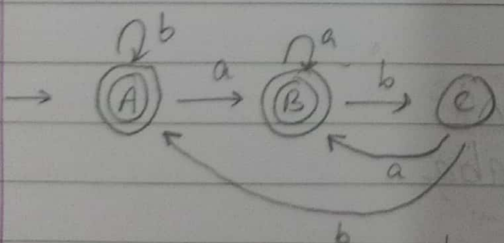
Atleast 2 a's

3.



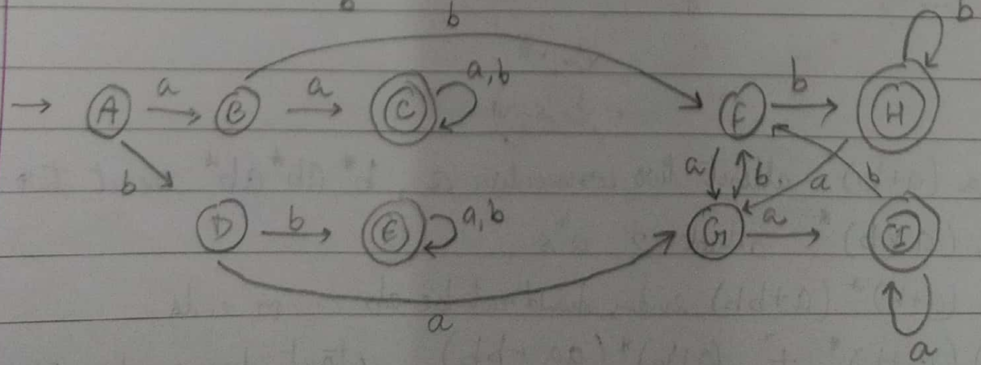
ending with ab

$\Downarrow$ compliment



not ending with ab

4.

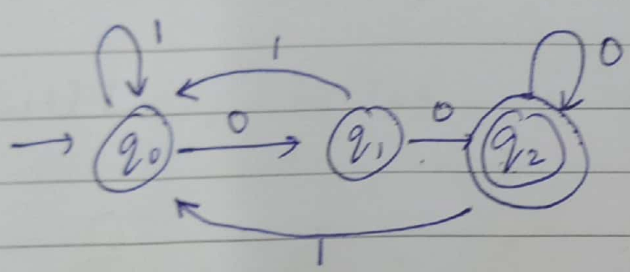


Finite Autometa

Eg1: $M = (Q, \Sigma, q_0, A, \delta)$

Q = set of states
Σ = set of i/p symbol 0/1
q_0 = initial state
A = accepting state.
$\delta = Q \times \Sigma \rightarrow Q$

FA: =



state	i/p 0	1
q_0	q_1	q_0
q_1	q_2	q_0
q_2	q_2	q_0

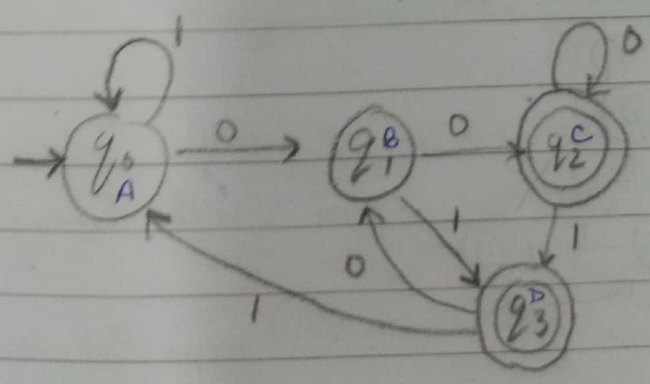
$\delta(q_0, 0) = q_1$
$\delta(q_0, 1) = q_0$
$\delta(q_1, 0) = q_2$
$\delta(q_1, 1) = q_0$
$\delta(q_2, 0) = q_2$
$\delta(q_2, 1) = q_0$

possible strings
00, 100, 10100, 0000, 0011000, ...

R.E.:= $(1+0)^*00$

Eg2: String with next to last symbol 0 : example : 00, 01, 10100, 11100, ...

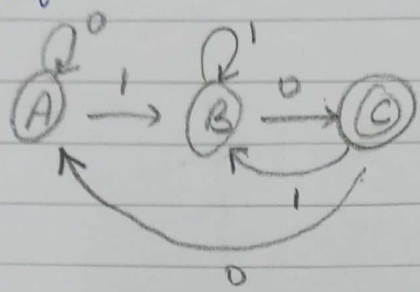
FA:



Q = ~~A, B, C, D~~ q_0, q_1, q_2, q_3
$\Sigma = 0, 1$
$q_0 = q_0$
$A = q_2, q_3$
$\delta = (A, 0) = B$
$\delta = (A, 1) = A$
$\delta = (B, 0) = C$
$\delta(B, 1) = D$
$\delta(C, 0) = C$

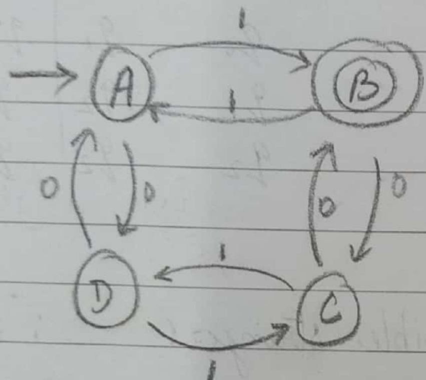
Q. String ending from 10 = RE $(1+0)^*10$

F A.

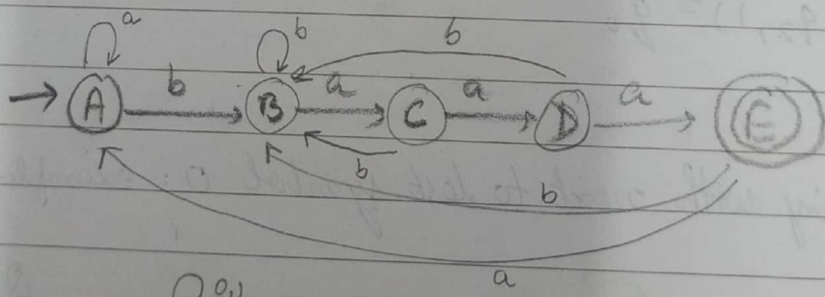


Q. Even no. of 0's and odd no of 1's

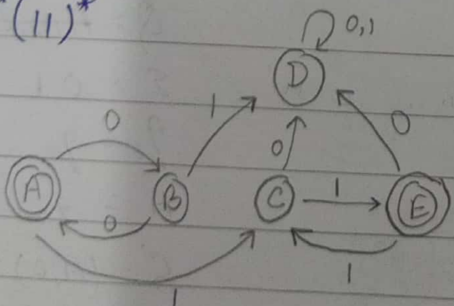
F.A.



Q. $(A+B)^*$ baaa



Q. $(00)^*(11)^*$



- Here D is the dummy state
- (A) means that we can generate null as well.

$\delta(A,0) =$ ______

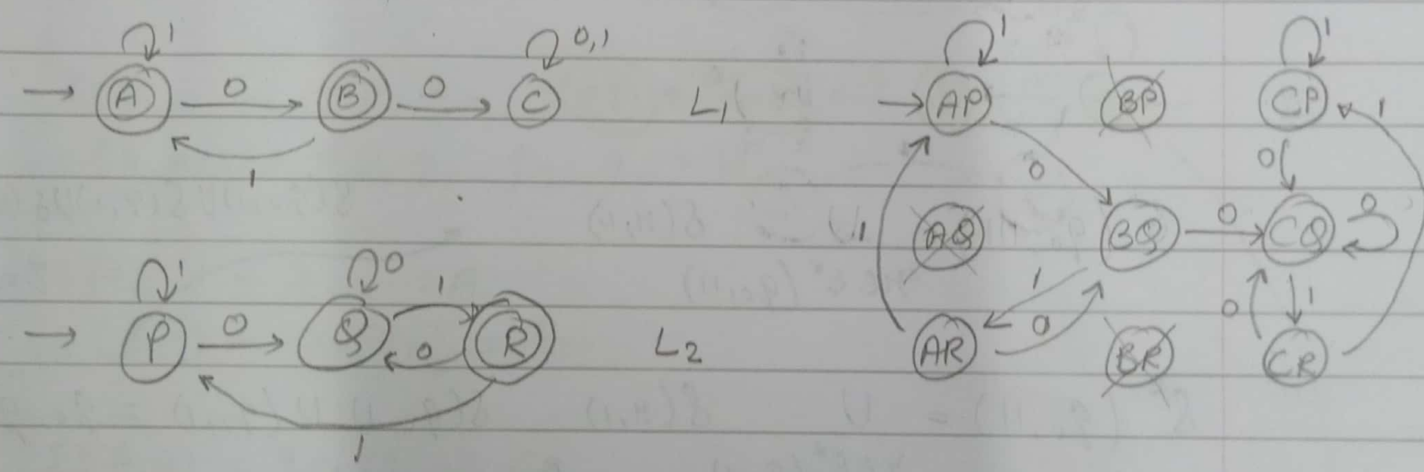
$\delta^*(A,00) =$ ______ δ^* (extended transition function)

Q. $M_1 = (Q_1, \Sigma, q_1, A, \delta_1) \rightarrow L_1$ language
$M_2 = (Q_2, \Sigma, q_2, A_2, \delta_2) \rightarrow L_2$ language

$L_1 \cup L_2$, $L_1 \cap L_2$, $L_1 - L_2$, $L_2 - L_1$

M_1

M_2



End states:
M_1 : A, B
M_2 : R

$\therefore L_1 \cup L_2 \rightarrow$ AR (where you see A, B & R
AP, BQ, CR

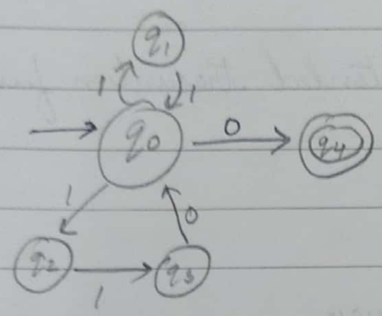
$\therefore L_1 \cap L_2 \rightarrow$ AR

$\therefore L_1 - L_2 \rightarrow$ AP, BQ (included in L_1 but not in L_2)

$\therefore L_2 - L_1 \rightarrow$ CR (included in L_2 but not in L_1)

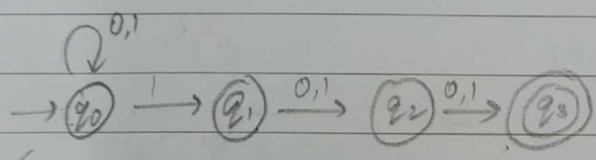
Non-Deterministic finite Automata ↴

Q. $(11+110)^{*}0$



(It can have null value (ϕ) and also q_1, q_2)

	0	1
q_0	q_4	q_1, q_2
q_1	ϕ	q_0
q_2	ϕ	q_3
q_3	q_0	ϕ
q_4	ϕ	ϕ

Q. 

$$\delta^{*}(q_0, 111) = \bigcup_{r \in \delta^{*}(q_0, 11)} \delta(r, 1)$$

$\delta(q_0,1) \cup \delta(q_1,1) \cup \delta(q_2,1)$

$= q_0, q_1, q_2, q_3$

$$\delta^{*}(q_0, 11) = \bigcup_{r \in \delta^{*}(q_0, 1)} \delta(r, 1)$$

$\delta(q_0, 1) \cup (q_1, 1) = q_0, q_1, q_2$

$$\delta^{*}(q_0, 1) = \bigcup_{r \in \delta^{*}(q_0, 1)} \delta(r, 1) = q_0, q_1$$

Subset Construction Algo (NFA → DFA)

Same example

→ Starting from the starting stage

$\delta(q_0, 0) = q_0$ A

$\delta(q_0, 1) = q_0, q_1$ B

$\therefore \delta(A, 0) = q_0 = A$, $\delta(A, 1) = q_0, q_1 = B$

$\therefore \delta(B,0) = \delta(q_0,0) \cup \delta(q_1,0)$
$= q_0, q_2 = C$

$\delta(B,1) = \delta(q_0,1) \cup \delta(q_1,1)$
$= q_0, q_1, q_2 = D$

$\therefore \delta(C,0) = \delta(q_0,0) \cup \delta(q_2,0)$
$= q_0 q_3 = E$

$\delta(C,1) = q_0, q_1, q_3 = F$

$\therefore \delta(D,0) = q_0, q_2, q_3 = G$
$\delta(D,1) = q_0, q_1, q_3, q_2 = H$

$\delta(E,0) = q_0 = A$
$\delta(E,1) = q_0, q_1 = B$

$\delta(F,0) = q_0, q_2 = C$
$\delta(F,1) = q_0, q_1, q_2 = D$

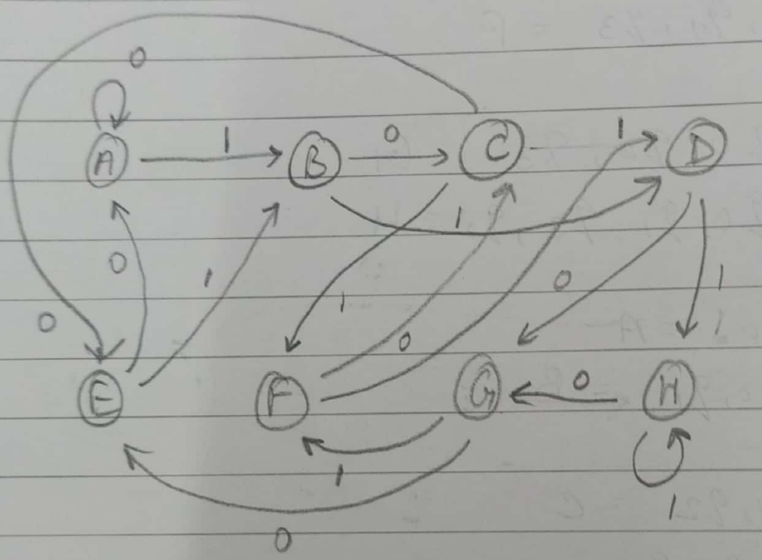
$\delta(G,0) = q_0, q_3 = E$
$\delta(G,1) = q_0, q_1, q_3 = F$

$\delta(H,0) = q_0, q_2, q_3 = G$
$\delta(H,1) = q_0, q_1, q_2, q_3 = H$

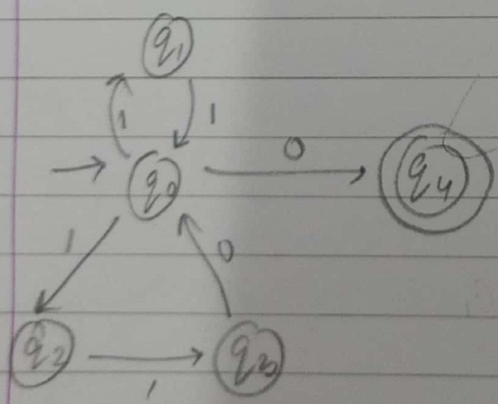
Hence, Number of states = A, B, C, D, E, F, G, H

P.T.O.

	$\delta(q,0)$	$\delta(q,1)$
A	A	B
B	C	D
C	E	F
D	G	H
E	A	B
F	C	D
G	E	F
H	G	H



Q.



$\delta(q_0, 0) = q_4 = A$
$\delta(q_0, 1) = q_1, q_2 = B$

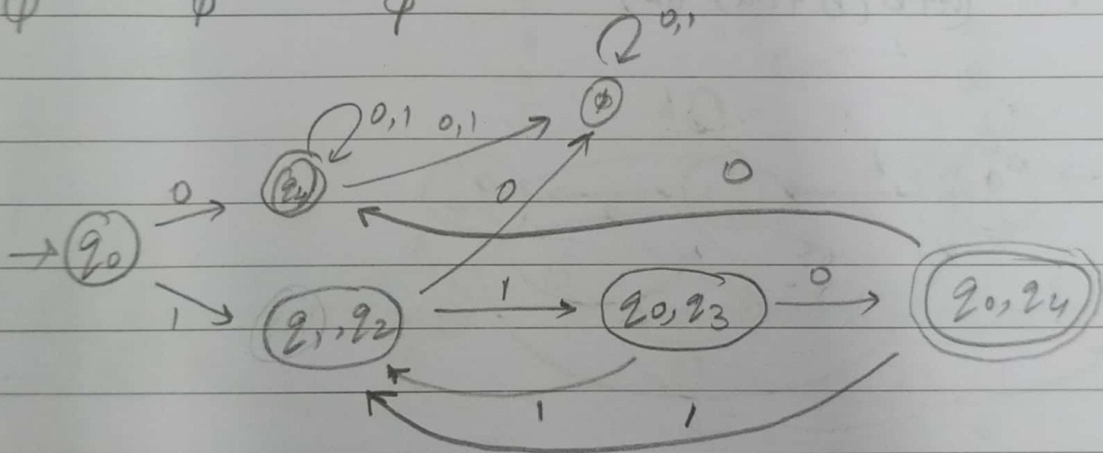
$\delta(A, 0) = \phi$ $\qquad$ $\delta(B, 0) = \phi$
$\delta(A, 1) = \phi$ $\qquad$ $\delta(B, 1) = q_0, q_3 = C$

$\delta(\phi, 0) = \phi$ $\qquad$ $\delta(\phi, 1) = \phi$

$\delta(C,0) = q_4, q_0 = D$
$\delta(C,1) = q_1, q_2 = B$

$\delta(D,0) = q_4 = A$
$\delta(D,1) = q_1 q_2 = B$

	$\delta(q,0)$	$\delta(q,1)$
A	ϕ	ϕ
B	ϕ	C
C	D	B
D	A	B
ϕ	ϕ	ϕ



→ As the original diagram has q_4 as end state hence those states having q_4 will be the end state

TUTORIAL - 3

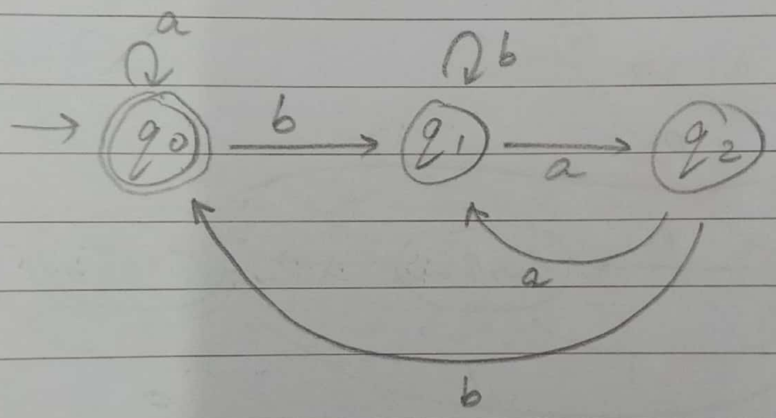
Q1.

1. (i) $(0^*1)^* = (0+1)^*$ Contradiction : 0, 10, 101
(ii) $(0+1)^* 01 (0+1)^* + 1^* 0^* \neq (0+1)^*$ all the strings are possible

Hence

~~Only (ii) is true option (B)~~ Option D is true

2. DFA : $(a+b(b+aa)^* ab)^*$

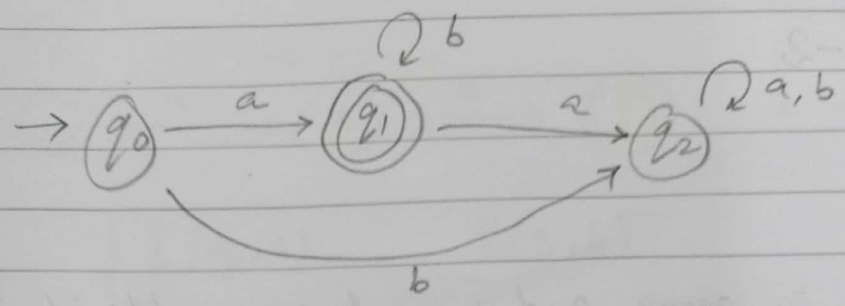


3. $(a+b)^* a (a+b)^* b (a+b)^*$ is equivalant to

Ans. ~~$(a+b)^* b (a+b)^* a (a+b)^*$~~ $(a+b)^* ab (a+b)^*$

4. Not in course :)
Q3. " " " :)

5.



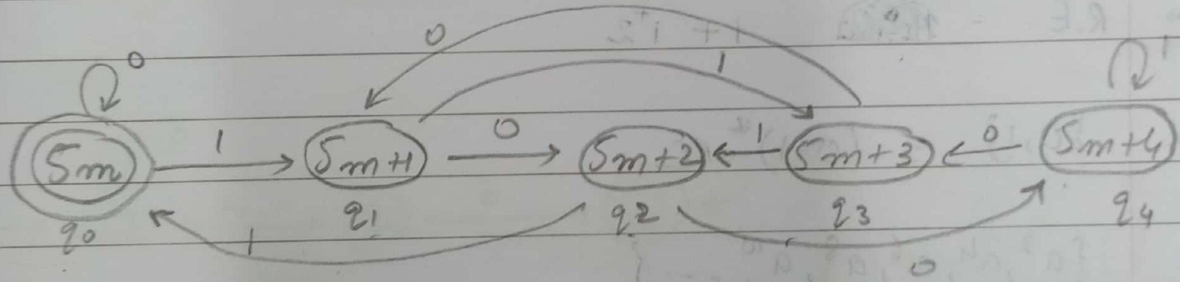
$L = \{ab^n \mid n \geq 0\}$

Q2.
5 - 101
10 - 1001
15 - 1111
20 - 10100

Text Book 3.21 (Divisible by 3)

0
1
2
3
4

5/5 = 0
6/5 1
7 2
10/5 0



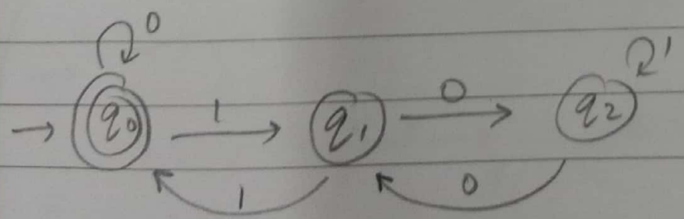
Eg 25 = 16+8+1
= 11001

$q_0 \xrightarrow{1} q_1 \xrightarrow{1} q_3 \xrightarrow{0} q_1 \xrightarrow{0} q_2 \xrightarrow{1} q_0$

Hence end state is
$5m = q_0$
hence divisible by 5

3.21

$q_0 = 0,\ q_1 = 1,\ q_2 = 2$ 0, 1, 2 = remainder



Tutorial-2

Q.4.

Ans Mostly used in games and is used in artificial intelligence and also frequent in executions of navigating parsing text, input handeling of the customer and also the network protocol

→ Used in vending machine, video games, traffic lights, controller in CPU, text parsing, recognition of speech, language processing

Q5.

a. $\{1, 12, 112, 1112, 11112, ...\}$

Ans R.E. = $1 + 1^{+}2$

b. $\{0,1\}$ = $(0+1)^{*}$ = RE.

c $\{a^2, a^4, a^6, a^8, a^{10}, ...\}$

Ans $a^2(a^2)^{*}$ = RE.

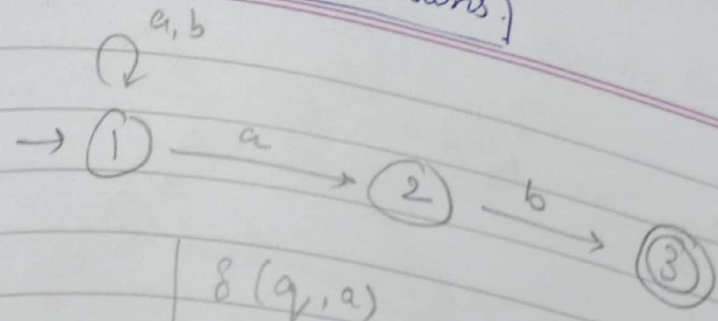
d. $\{a^x \mid x$ is divisible by 3 or 5 $\}$

Ans. $(a^3)^{*} + (a^5)^{*}$

Scanned with CamScanner

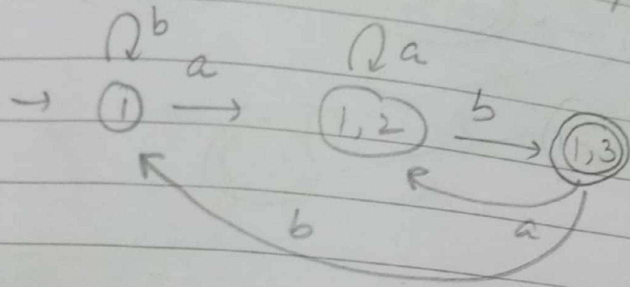
NFA to DFA conversions

Q.



= NFA

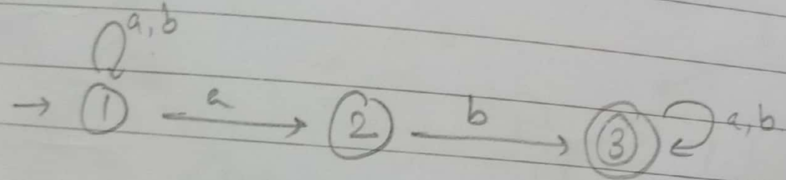
	$\delta(q,a)$	$\delta(q,b)$
1	1, 2	1
2	ϕ	3
3	ϕ	ϕ



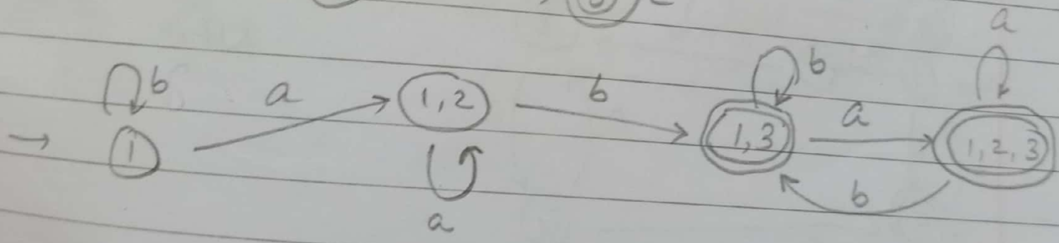
= DFA

Q.

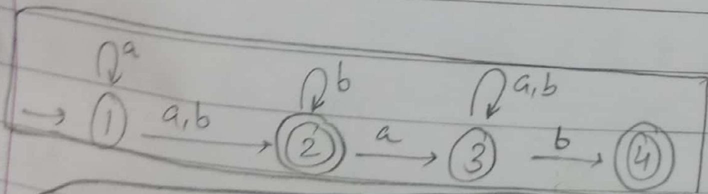
NFA



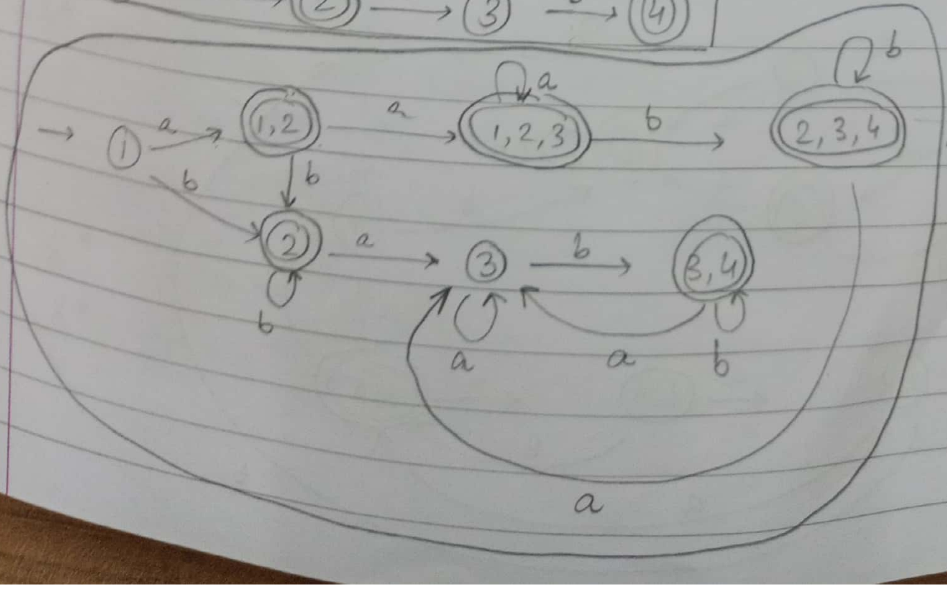
DFA



Q.



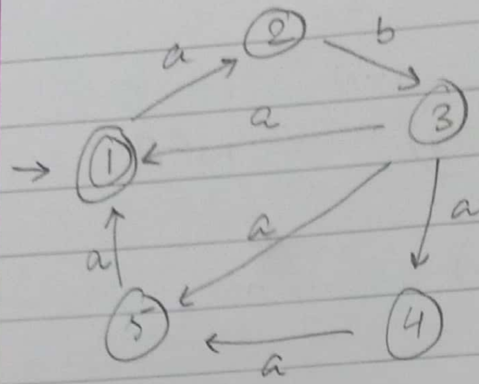
← NFA



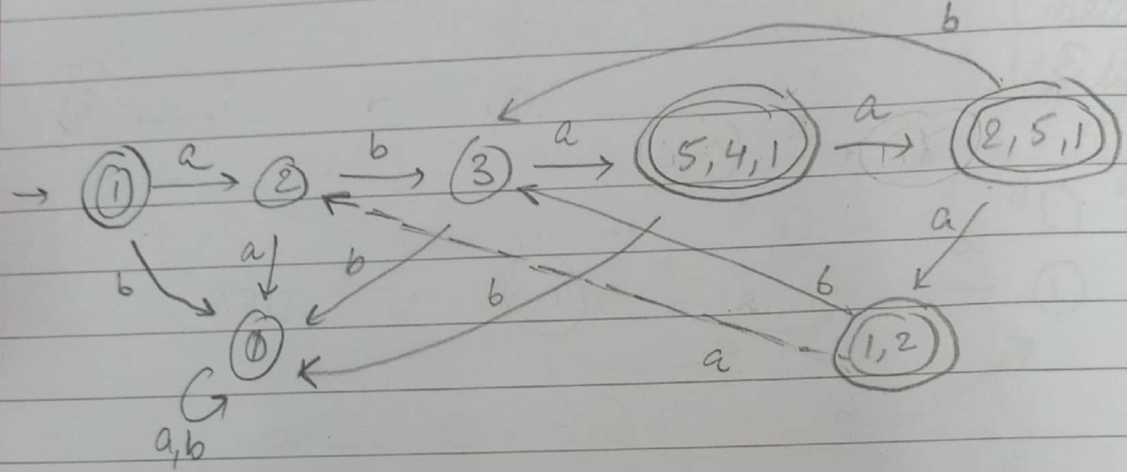
← DFA

Q.

NFA

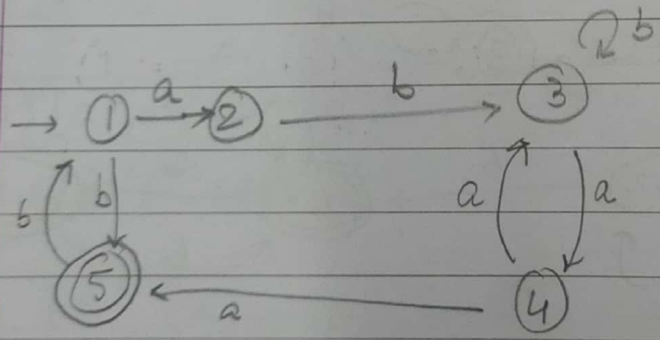


DFA

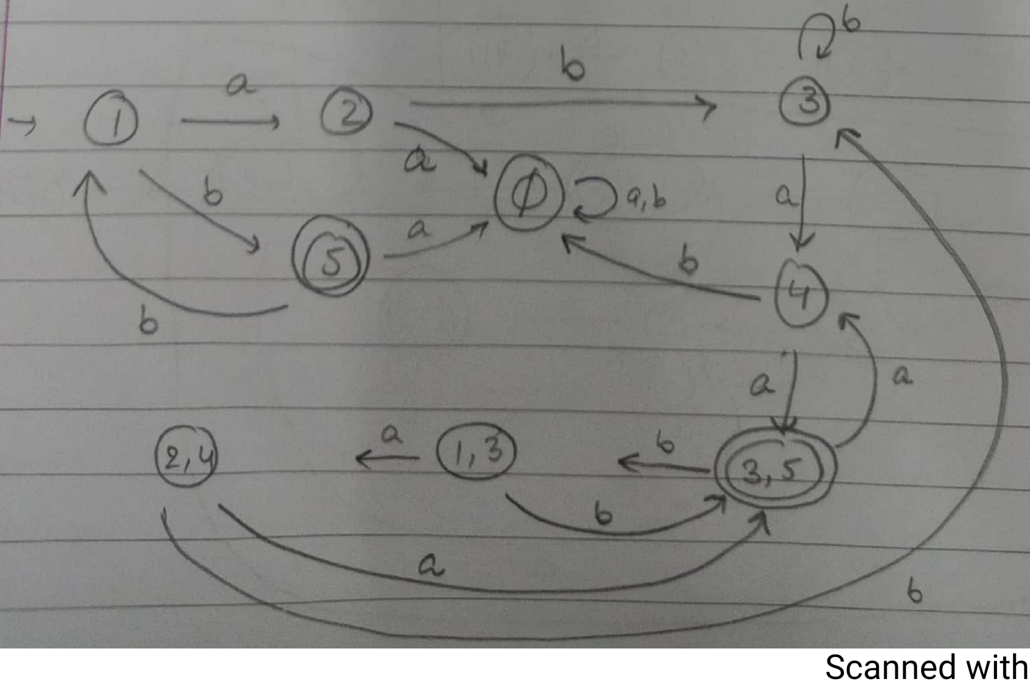


Q.

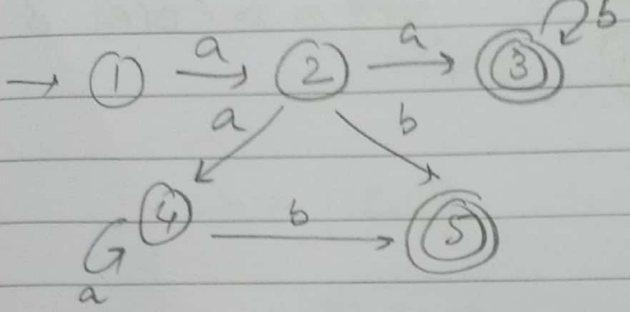
NFA



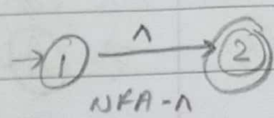
DFA



Q.

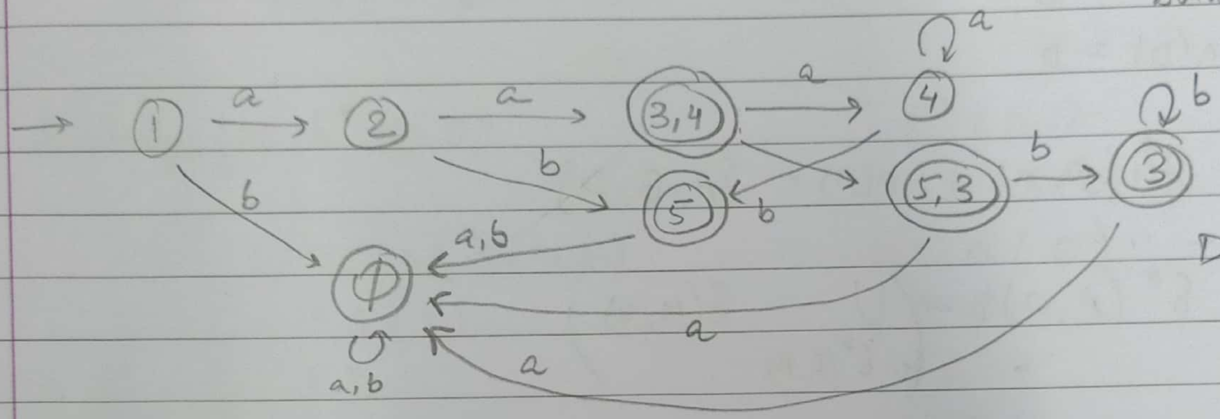


NFA



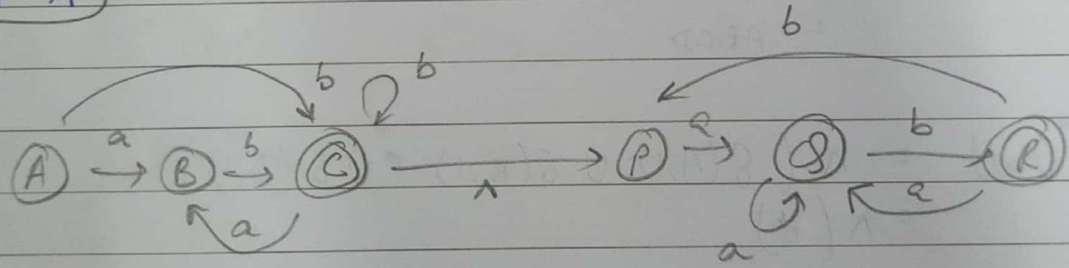
NFA - Λ

- Here the DFA and NFA diagrams will have 1 & 2 both as ending state.



DFA

NFA - Λ



NFA - Λ

An NFA-Λ is a 5 tuple $(Q, \Sigma, q_0, A, \delta)$

Q = set of i/p state

q_0 = Starting state

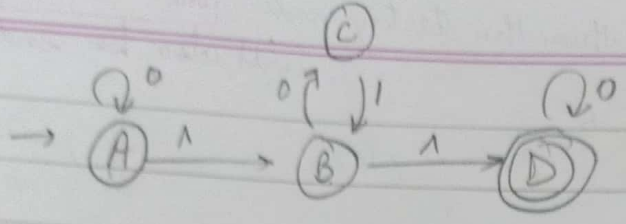
Rest all is same except $\longrightarrow \delta$

$\delta : Q \times \Sigma \cup \{\Lambda\} \rightarrow 2^Q$

↑ union

δ^* : NFA Λ

$\delta^* : Q \times \Sigma^* \rightarrow 2^Q$

Q  NFA-Λ to DFA

$\Lambda(A) = A, B, D$

$\Lambda(B) = B, D$

$\Lambda(C) = C$

$\Lambda(D) = D$

$\delta^*(A, \Lambda) = \Lambda(A) = \{A, B, D\}$

$$\delta^*(A, 0) = \Lambda\left(\bigcup_{r = \delta^*(A,\Lambda)} \delta(r, 0)\right)$$

$= \Lambda(\delta(A,0) \cup \delta(B,0) \cup \delta(D,0))$

$= \Lambda(A, C, D)$

$= ABCD$

$\delta^*(A,1) = \Lambda(\delta(A,1) \cup \delta(B,1) \cup \delta(D,1))$

$= \Lambda(\phi)$

$= \phi$

$$\delta^*(B,0) = \Lambda\left(\bigcup_{r \in \delta^*(B,\Lambda)} \delta(r, 0)\right)$$

$= \Lambda(\delta(B,0) \cup \delta(D,0))$

$= \Lambda(C, D)$

$= C, D$

$\delta^*(B,1) = \Lambda(\delta(B,1) \cup \delta(D,1))$

$= \Lambda(\phi)$

$= \phi$

Page No.:
Date:

$\delta^*(C,0) = \Lambda\left(\bigcup_{r \in \delta^*(C,\Lambda)} \delta(r,0)\right)$

$= \Lambda(\delta(C,0))$

$= \Lambda(\emptyset) = \emptyset$

$\delta^*(C,1) = \Lambda(\delta(C,1))$

$= \Lambda(B)$

$= B, D$

Similarly for $\delta^*(D,0)$

$= \Lambda(\delta(D,0))$

$= \Lambda(D)$

$= D$

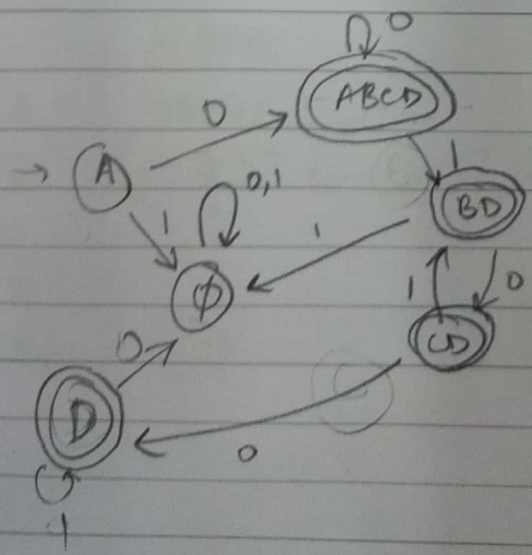
$\delta^*(D,1)$

$= \Lambda(\delta(D,1))$

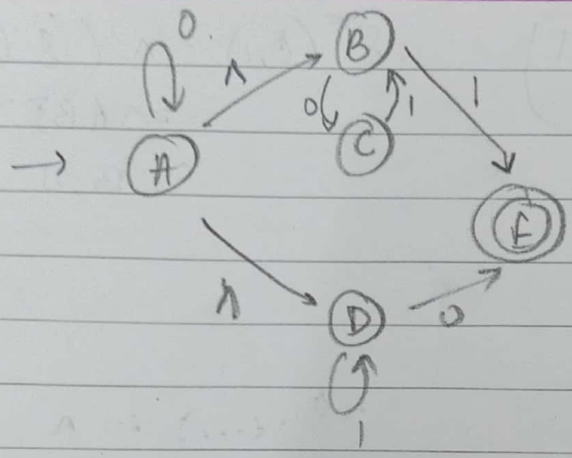
$= \Lambda(\emptyset)$

$= \phi$

q	$\delta^*(q,0)$	$\delta^*(q,1)$
A	A,B,C,D	ϕ
B	C,D	ϕ
C	ϕ	B,D
D	D	ϕ



Q.



$\Lambda(A) = ABD$

$\Lambda(B) = B$

$\Lambda(C) = C$

$\Lambda(D) = D$

$\Lambda(E) = E$

$$\delta^*(A,0) = \Lambda\left(\bigcup_{r \in \delta^*(A,\Lambda)} (r,0)\right)$$

$$= \Lambda\left(\delta(A,0) \cup \delta(B,0) \cup \delta(D,0)\right)$$

$$= \Lambda(A, C, E)$$

$$= ABCDE$$

$$\delta^*(A,1) = \Lambda\left(\delta(A,1) \cup \delta(B,1) \cup \delta(D,1)\right)$$

$$= \Lambda(E, D)$$

$$= E, D$$

	Page No.:	
	Date:	YOUVA

$\delta^*(B,0) = \Lambda(\delta(B,0))$

$= \Lambda(C)$

$= C$

$\delta^*(B,1) = \Lambda(\delta(B,1))$

$= \Lambda(E)$

$= E$

$\delta^*(C,0) = \Lambda(\delta(C,0))$

$= \Lambda(\phi)$

$= \phi$

$\delta^*(C,1) = \Lambda(\delta(C,1))$

$= \Lambda(B)$

$= B$

$\delta^*(D,0) = \Lambda(\delta(D,0))$

$= \Lambda(E)$

$= E$

$\delta^*(D,1) = \Lambda(\delta(D,1))$

$= \Lambda(D)$

$= D$

$\delta^*(E,0) = \Lambda(\delta(E,0))$

$= \Lambda(\emptyset)$

$= \phi$

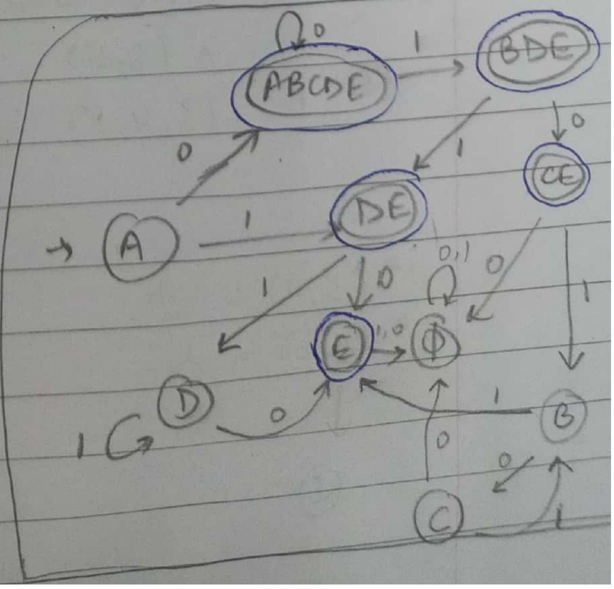
$\delta^*(E,1) = \Lambda(\delta(E,1))$

$= \Lambda(\emptyset)$

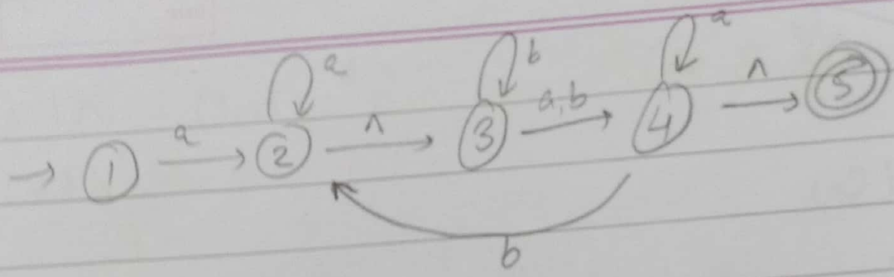
$= \phi$

	$\delta(q,0)$	$\delta(q,1)$
A	ABCDE	DE
B	C	E
C	ϕ	B
D	E	D
E	ϕ	ϕ

NFA-Λ to DFA



8.



$\wedge(1) = 1$
$\wedge(2) = 2,3$
$\wedge(3) = 3$
$\wedge(4) = 4,5$
$\wedge(5) = 5$

$\delta^*(1,a) = \wedge(\delta(1,a))$
$= \wedge(2)$
$= (2,3)$

$\delta^*(1,b) = \wedge(\delta(1,b))$
$= \wedge(\phi) = \phi$

$\delta^*(2,a) = \wedge(\delta(2,a) \cup \delta(3,a))$
$= \wedge(2,3,4)$
$= (2,3,4,5)$

$\delta^*(2,b) = \wedge(\delta(2,b) \cup \delta(3,b))$
$= \wedge(3,4)$
$= (3,4,5)$

$\delta^*(3,a) = \wedge(\delta(3,a))$
$= \wedge(4)$
$= 4,5$

$\delta^*(4,a) = \wedge(\delta(4,a) \cup \delta(5,a))$
$= \wedge(4)$
$= (4,5)$

$\delta^*(3,b) = \wedge(\delta(3,b))$
$= \wedge(3,4)$
$= (3,4,5)$

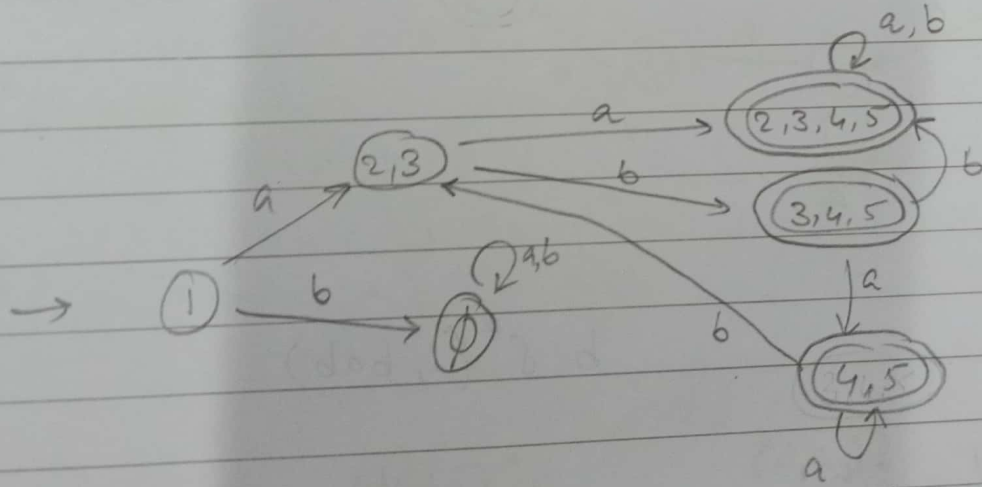
$\delta^*(4,b) = \wedge(\delta(4,b) \cup \delta(5,b))$
$= \wedge(2)$
$= (2,3)$

$\delta^*(5,a) = \phi$
$\delta^*(5,b) = \phi$

Date:

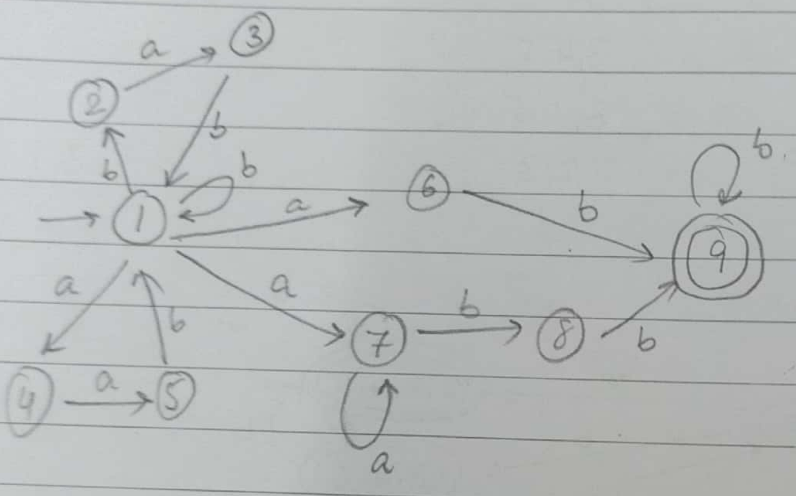
YOUVA

q	$\delta(q,a)$	$\delta(q,b)$
1	2,3	ϕ
2	2,3,4,5	3,4,5
3	4,5	3,4,5
4	4,5	2,3.
5	ϕ	ϕ



TUTORIAL - 4

Q1.



a $\delta^*(1, bb)$

$\delta^*(1,bb) = \bigcup_{r \in \delta^*(1,b)} \delta(r,b)$

$\delta^*(1,b) = \bigcup_{r \in \delta^*(1,\Lambda)} \delta(r,b)$

$\delta^*(1,b) = \delta(1,b) = \{1,2\}$

$\delta^*(1,bb) = \delta(1,b) \cup \delta(2,b)$

$\delta^*(1,bb) = \{1,2\}$

b. $\delta^*(1, bab)$

$\delta^*(1,bab) = \bigcup_{r \in \delta^*(1,ba)} \delta(r,b)$

$= \bigcup_{r \in \delta^*(1,b)} \delta(r,a)$

$= \bigcup_{r \in \delta^*(1,\Lambda)} \delta(1,b)$

$= \{1,2\}$

δ^* $(1,a)$, $(2,a)$

$\{4,6,7,3\}$

$(4,b)$, $(6,b)$, $(7,b)$, $(3,b)$

$= \{1,9,8\}$

c. $\delta^*(1, aabb)$

$$\delta^*(1,aabb) = \bigcup_{r \in \delta^*(1,aab)} \delta(r,b)$$

$$\delta^*(1,aab) = \bigcup_{r \in \delta^*(1,aa)} \delta(r,b)$$

$$\delta^*(1,aa) = \bigcup_{r \in \delta^*(1,a)} \delta(r,a)$$

$$\delta^*(1,a) = \bigcup_{r \in \delta^*(1,\Lambda)} \delta(r,a)$$

$$= \delta(1,a) = \{4,6,7\}$$

$$\delta^*(1,aa) = \delta(4,a) \cup \delta(6,a) \cup \delta(7,a)$$
$$= \{5,7\}$$

$$\delta^*(1,aab) = \{1,8\}$$
$$\delta^*(1,aabb) = \{1,2,9\}$$

d. $\delta^*(1,aabbab)$

δ^* frome $\{1,2,9\}$

$$= (1,a) \cup (2,a) \cup (9,a)$$
$$= \{6,7,4,3\}$$
$$(6,b),(7,b),(4,b),(3,b)$$
$$= \{9,8,1\}$$

e. $\delta^*(1,aba)$

$$\delta^*(1,aba) = \bigcup_{r \in \delta^*(1,ab)} \delta(r,a) \quad \boxed{\phi}$$

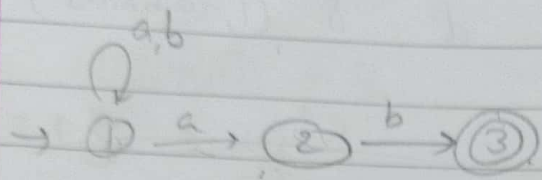
$$\delta^*(1,ab) = \bigcup_{r \in \delta^*(1,a)} \delta(r,b) \quad \{9,8\}$$

$$\delta^*(1,a) = \bigcup_{r \in \delta^*(1,\Lambda)} \delta(r,a)$$

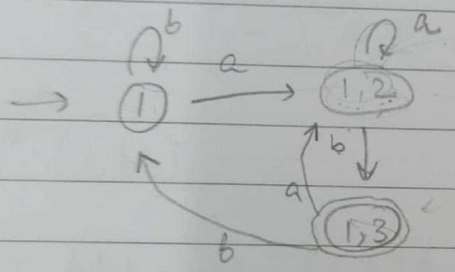
$$= \{6,7,4\}$$

Q2.

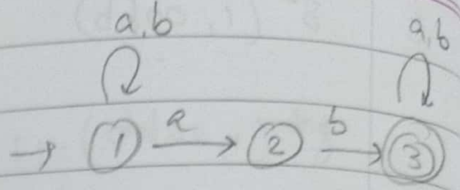
$\boxed{a}$

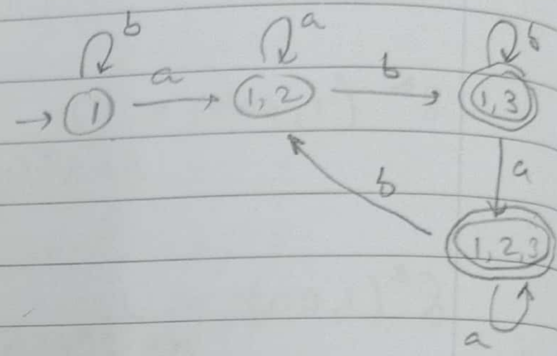


	q,a	q,b
1	(1,2)	1
2	ϕ	3
3	ϕ	ϕ

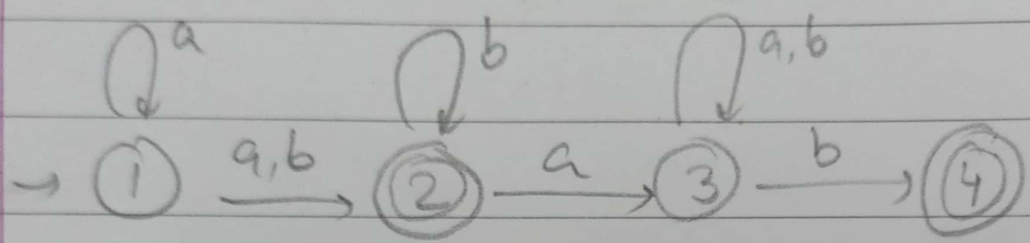


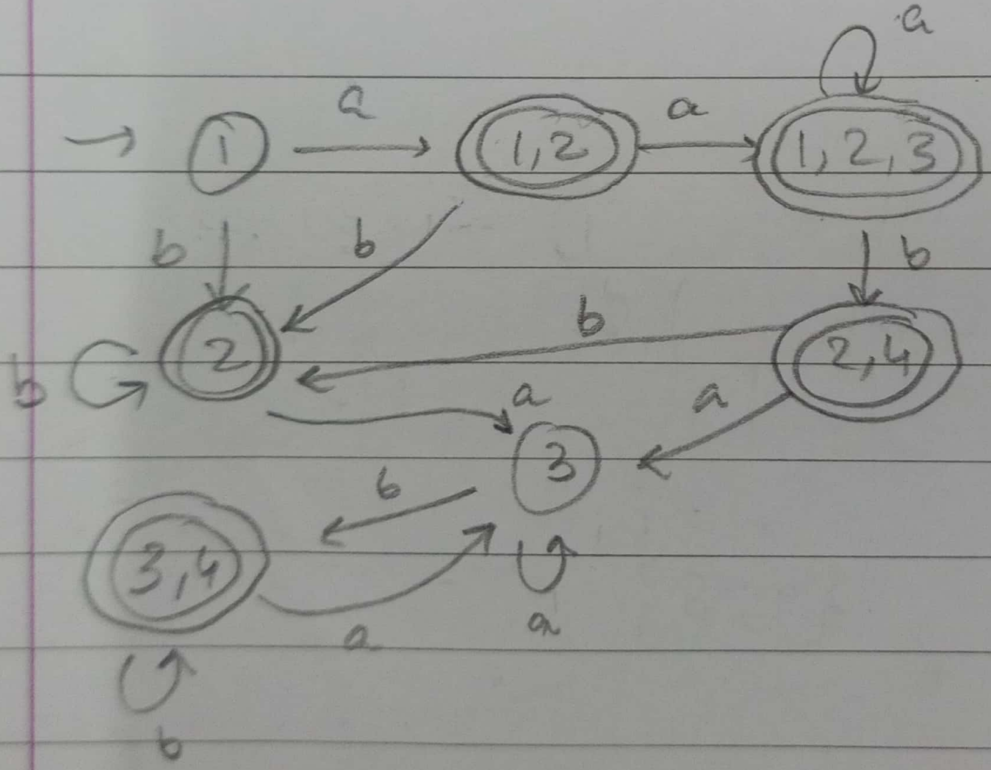
$\boxed{b}$



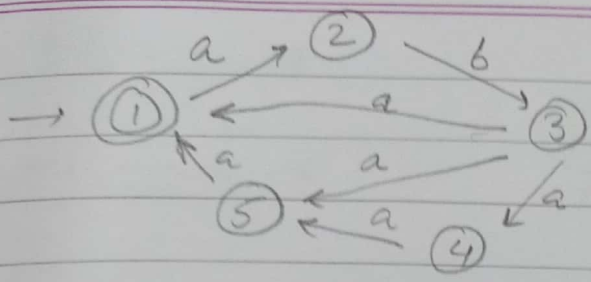


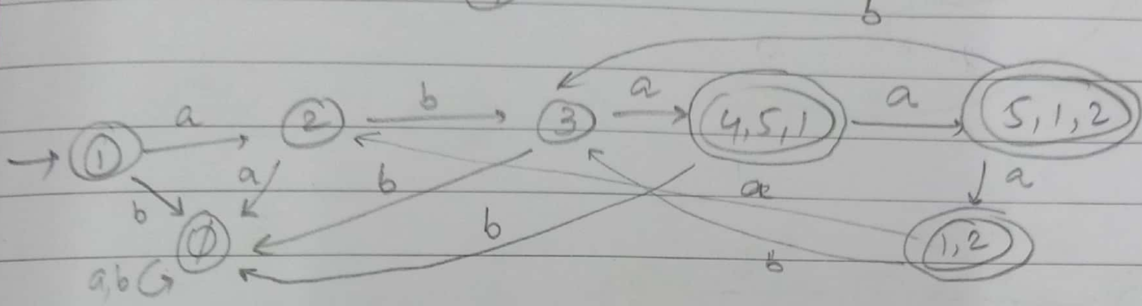
C.



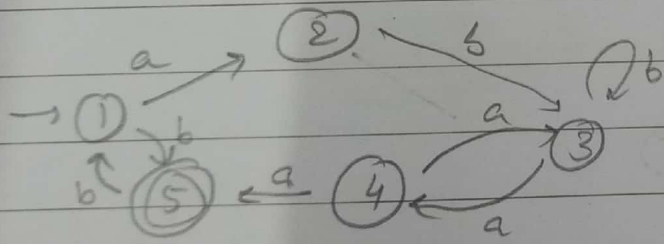


d

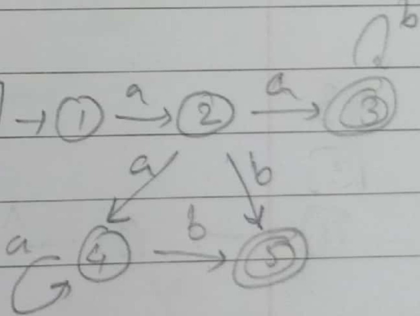

1
2
3
4
5
a
b
a
a
a
a
a

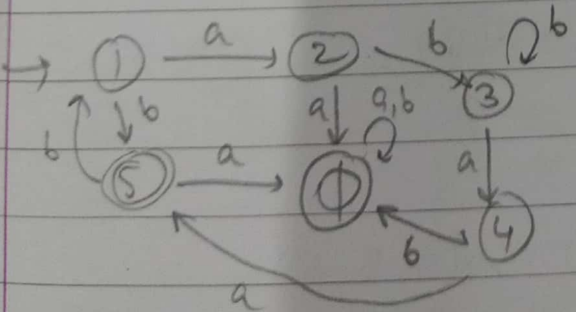

1
2
3
4,5,1
5,1,2
1,2
∅
a
b
a
a
a
b
b
b
a
b
a,b

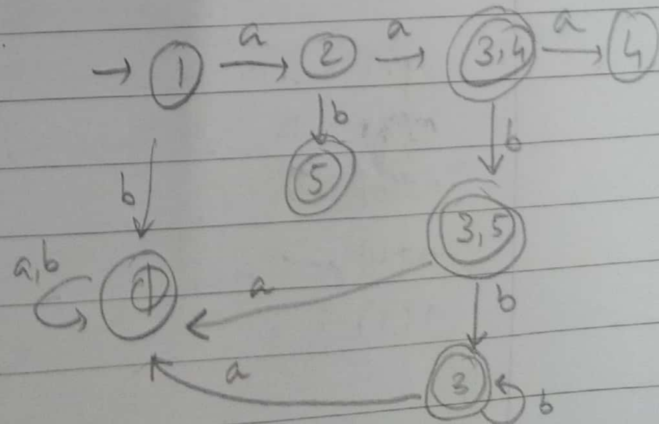
e


1
2
3
4
5
a
b
b
a
a
a
b
b

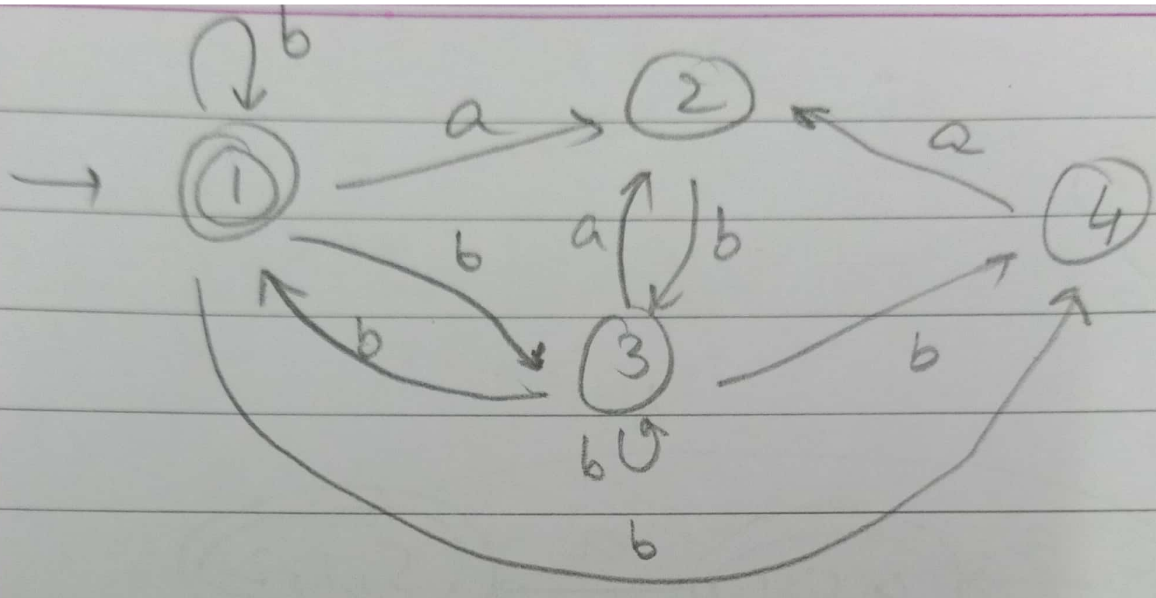
f

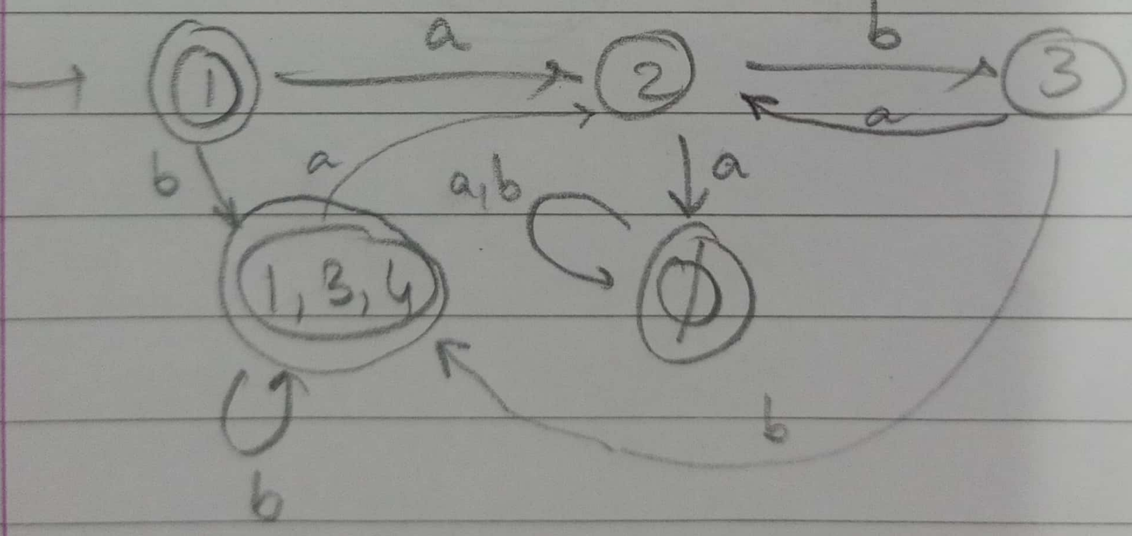

1
2
3
4
5
a
a
b
a
b
b
a


1
2
3
4
5
Φ
a
b
b
b
b
a
a,b
a
a
b
a

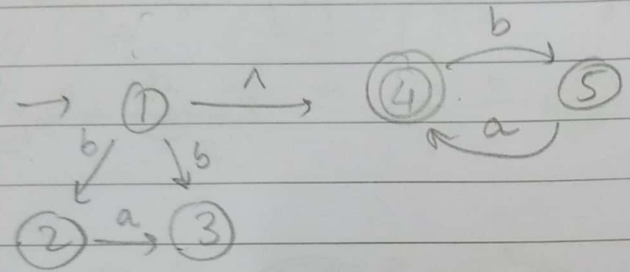

1
2
3,4
4
5
3,5
3
Φ
a
a
a
b
b
b
b
a
a
b
a,b

9





Q3.

(1) 

1 & 4 will be the end states

$\Lambda(1) = 1,4$

$\Lambda(2) = 2$

$\Lambda(3) = 3$

$\Lambda(4) = 4$

$\Lambda(5) = 5$

$\delta^*(1,a) = \Lambda(\phi) =$
$= \phi$
$=$

$\delta^*(1,b) = \Lambda(2,3,5)$
$= 2,3,5$

$\delta^*(2,a) = \Lambda(3)$
$= 3$

$\delta^*(2,b) = \Lambda(\phi)$
$= \{\phi\}.$
$=$

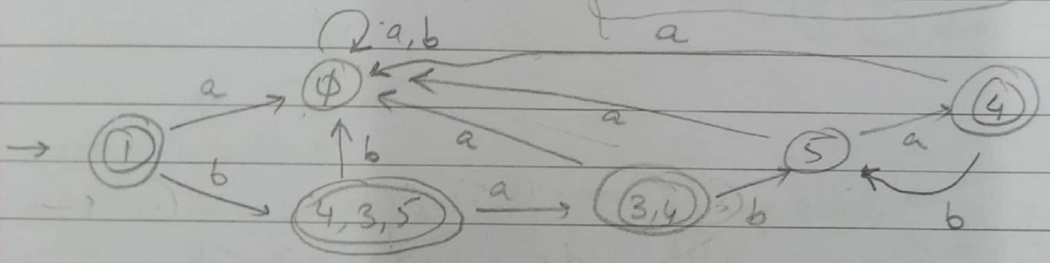
$\delta^*(3,a) = \Lambda\{\phi\}$
$= \phi$
$=$

$\delta^*(3,b) = \Lambda\{\phi\}$
$= \phi$

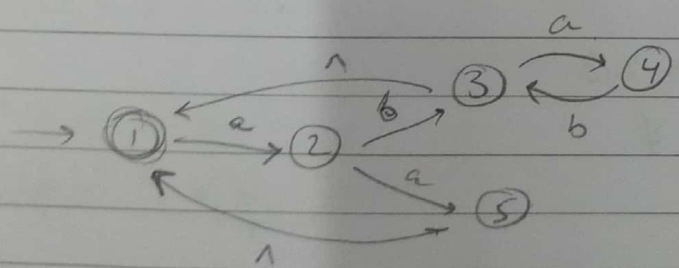
$\delta^*(4,a) = \phi$ $\quad$ $\delta^*(5,a) = 4$

$\delta^*(4,b) = 5$ $\quad$ $\delta^*(5,b) = \phi$

	$\delta^*(q,a)$	$\delta^*(q,b)$	$\delta(q,a)$	$\delta(q,b)$
1	ϕ	2,3,5	ϕ	2
2	3	ϕ	3	ϕ
3	ϕ	ϕ	ϕ	1
4	ϕ	5	ϕ	5
5	4	ϕ	4	ϕ



2.



$\wedge(1) = 1$
$\wedge(2) = 2$
$\wedge(3) = 3,1$
$\wedge(4) = 4$
$\wedge(5) = 5,1$

$\delta^*(1,a) = \wedge\{2\} = 2$ $\quad$ $\delta^*(2,a) = \wedge\{5\} = \{5,1\}$

$\delta^*(1,b) = \phi$ $\quad$ $\delta^*(2,b) = \wedge\{3\} = \{3,1\}$

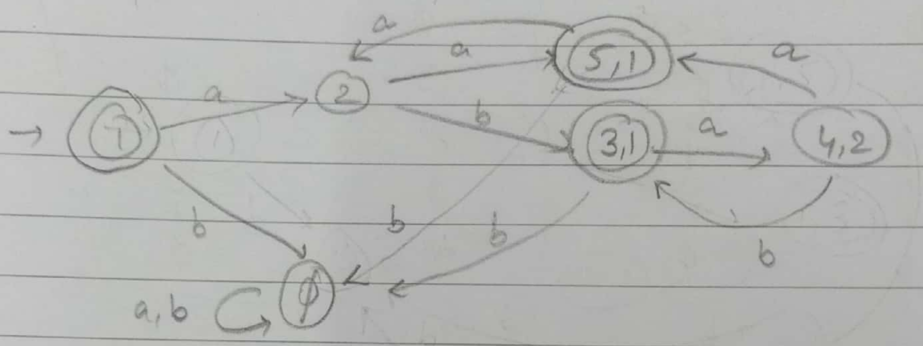
$\delta^*(3,a) = \wedge\{4,2\}$ $\quad$ $\delta^*(4,a) = \phi$ $\quad$ $\delta^*(5,a) = \wedge\{2\} = 2$

$(3,b) = \wedge\{\phi\} = \phi$ $\quad$ $\delta^*(4,b) = \wedge\{3\} = \{3,1\}$ $\quad$ $(5,b) = \wedge\{\phi\} = \phi$

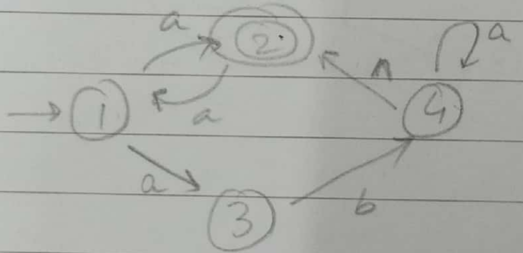
Scanned with CamScanner

Date:

	(q,a)	(q,b)
1	2	ϕ
2	5,1	3,1
3	4,2	ϕ
4	ϕ	3,1
5	2	ϕ



3.



$\wedge(1) = 1$

$\wedge(2) = 2$

$\wedge(3) = 3$

$\wedge(4) = 2,4$

$\delta^*(1,a) = \wedge\{2,3\} = 2,3$

$\delta^*(1,b) = \wedge\{\phi\} = \phi$

$\delta^*(2,a) = \wedge\{1\} = 1$

$\delta^*(2,b) = \wedge\{\phi\} = \phi$

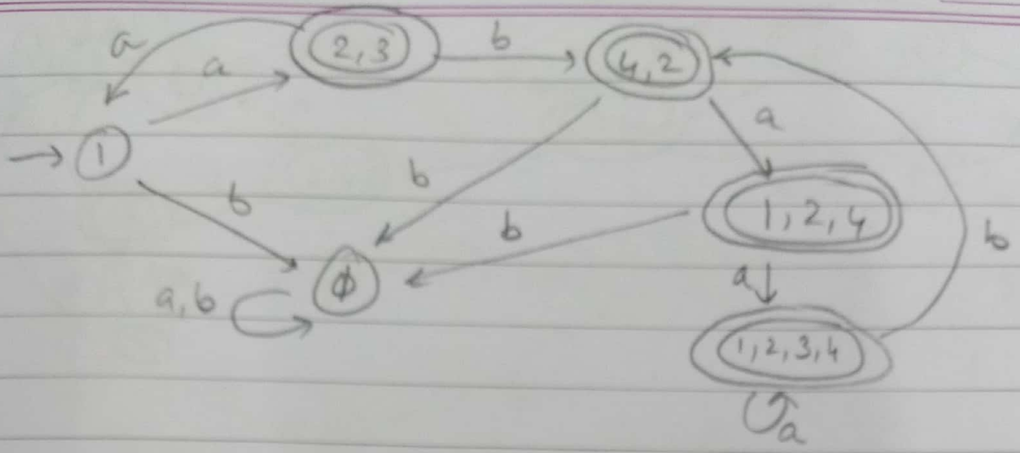
$\delta^*(3,a) = \wedge\{\phi\} = \phi$

$\delta^*(3,b) = \wedge\{4\} = 4,2$

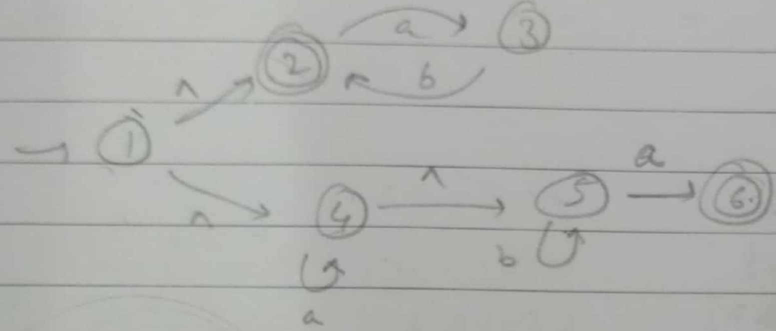
$\delta^*(4,a) = \wedge\{1,4\} = 1,2,4$

$\delta^*(4,b) = \wedge\{\phi\} = \phi$

	q,a	q,b
1	2,3	ϕ
2	1	ϕ
3	ϕ	4,2
4	1,2,4	ϕ



4.



Here 2, 3, 6 are considered as end stat

$\wedge(1) = 1,2,4,5$

$\wedge(2) = 2$

$\wedge(3) = 3$

$\wedge(4) = 4,5$

$\wedge(5) = 5$

$\wedge(6) = 6.$

$\delta^*(1,a) = \wedge\{3,4,6\} = \{3,4,5,6\}$

$\delta^*(1,b) = \wedge\{5\} = \{5\}$

$\delta^*(2,a) = \wedge\{3\} = 3$

$\delta^*(2,b) = \wedge\{\phi\} = \phi$

$\delta^*(3,a) = \phi$

$(3,b) = \wedge\{2\} = 2.$

$(4,a) = \wedge\{4,6\} = \{4,5,6\}$

$(4,b) = \wedge\{5\} = 5$

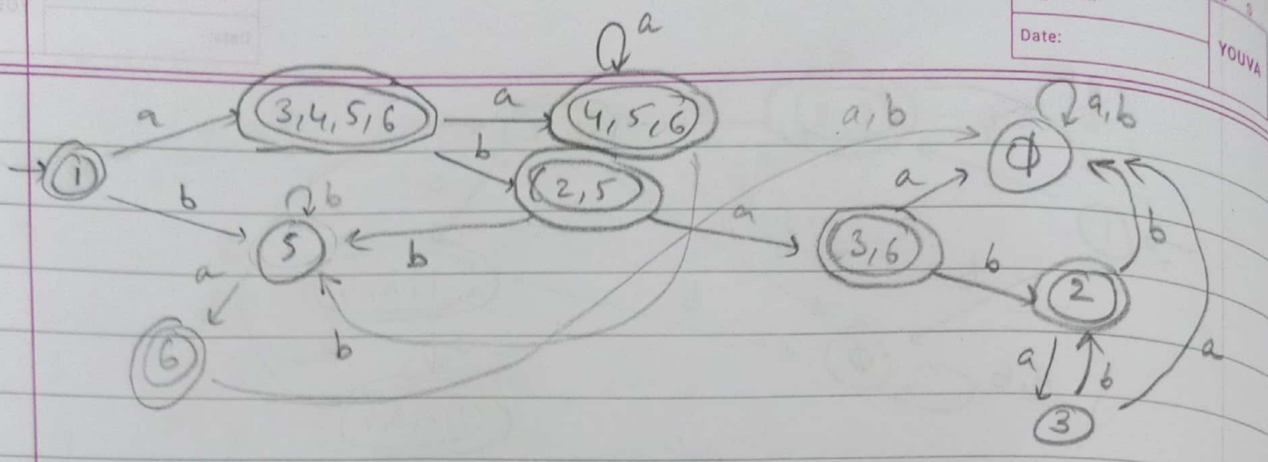
$(5,a) = 6$

$(5,b) = 5$

$(6,a) = \phi$

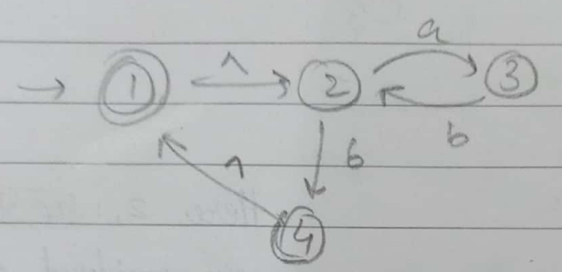
$(6,b) = \phi$

	q.a	q.b
1	3,4,5,6	5
2	3	ϕ
3	ϕ	2
4	4,5,6	5
5	6	5
6	ϕ	ϕ



Final state?

$\boxed{5.}$



$\delta^*_\wedge(1,a) = 3$

$\delta^*(1,b) = \wedge\{4\} = \{4,1,2\}$

$\wedge(1) = 1,2$

$\wedge(4) = 4,1$

$\wedge(2) = 2$

$\wedge(3) = 3$

$\delta^*(2,a) = 3$

$(2,b) = \wedge\{4\} = \{4,1,2\}$

$\delta^*(3,a) = \phi$

$(3,b) = \wedge\{2\} = 2$

$\delta^*(4,a) = 3$

$(4,b) = 1,2,4$

	q,a	q,b
1	3	4,1,2
2	3	4,1,2
3	ϕ	2
4	3	1,2,4