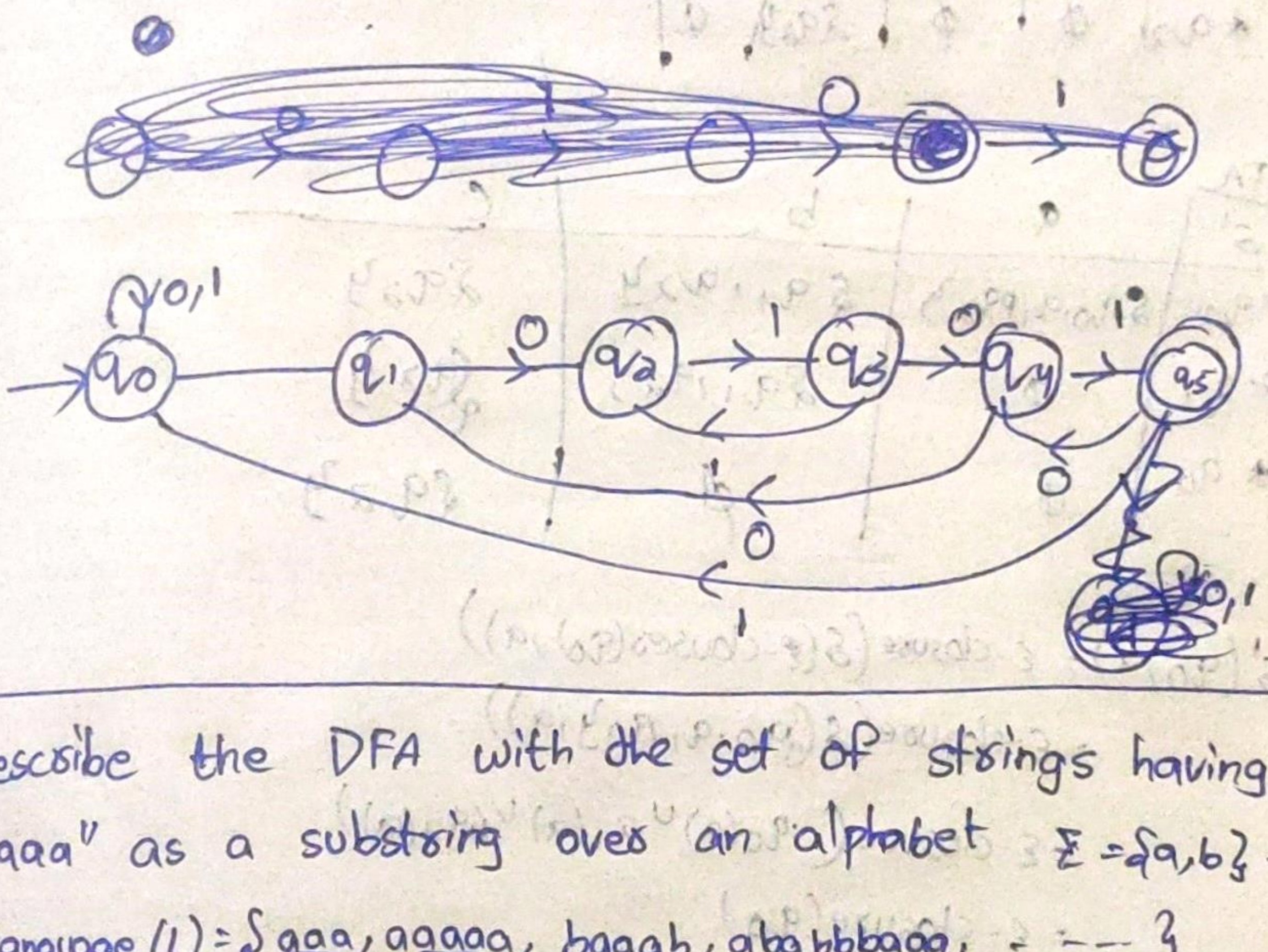
① Demonstrate DFA to accept set of all strings ending with 0101.

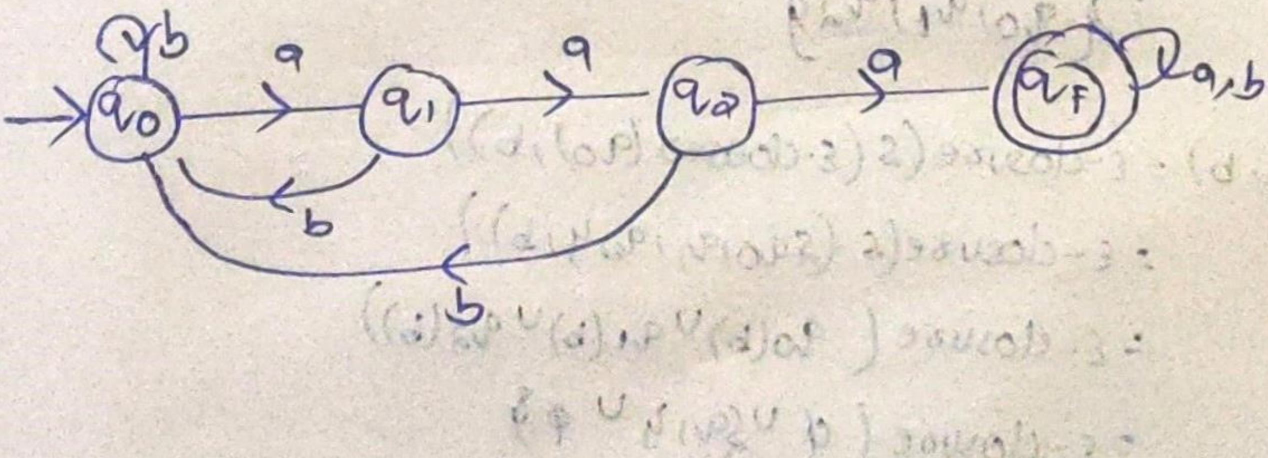
Ans:

Language (L) = {0101, 00101, 10101, 010101, 100101, ...}



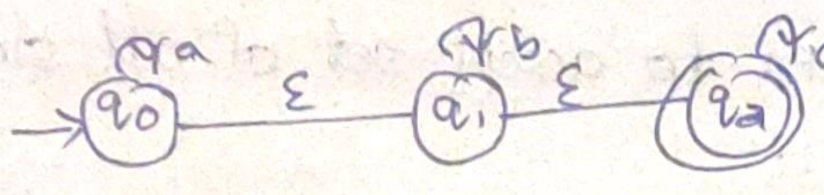
② Describe the DFA with the set of strings having "aaa" as a substring over an alphabet $\Sigma = \{a, b\}$.

Ans: language (L) = {aaa, aaaaa, baaab, ababbbaaa, - - - }



④ Describe NFA with ε to NFA conversion with an example.

Ans:



ε-NFA

δ	a	b	c	ε
→ q_0	$\{q_0\}$	ϕ	ϕ	$\{q_1\}$
q_1	ϕ	$\{q_1\}$	ϕ	$\{q_2\}$
* q_2	ϕ	ϕ	$\{q_2\}$	ϕ

ε-closure$(q_0) = \{q_0, q_1, q_2\}$

ε-closure$(q_1) = \{q_1, q_2\}$

ε-closure$(q_2) = \{q_2\}$

NFA

δ'	a	b	c
* → q_0	$\{q_0, q_1, q_2\}$	$\{q_1, q_2\}$	$\{q_2\}$
* q_1	ϕ	$\{q_1, q_2\}$	$\{q_2\}$
* q_2	ϕ	ϕ	$\{q_2\}$

$\delta'(q_0, a) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_0), a))$

$= \varepsilon\text{-closure}(\delta(\{q_0, q_1, q_2\}, a))$

$= \varepsilon\text{-closure}(q_0(a) \cup q_1(a) \cup q_2(a))$

$= \varepsilon\text{-closure}(q_0)$

$= \{q_0, q_1, q_2\}$

$\delta'(q_0, b) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_0), b))$

$= \varepsilon\text{-closure}(\delta(\{q_0, q_1, q_2\}, b))$

$= \varepsilon\text{-closure}(q_0(b) \cup q_1(b) \cup q_2(b))$

$= \varepsilon\text{-closure}(\phi \cup \{q_1\} \cup \phi)$

$= \varepsilon\text{-closure}(q_1)$

$= \{q_1, q_2\}$

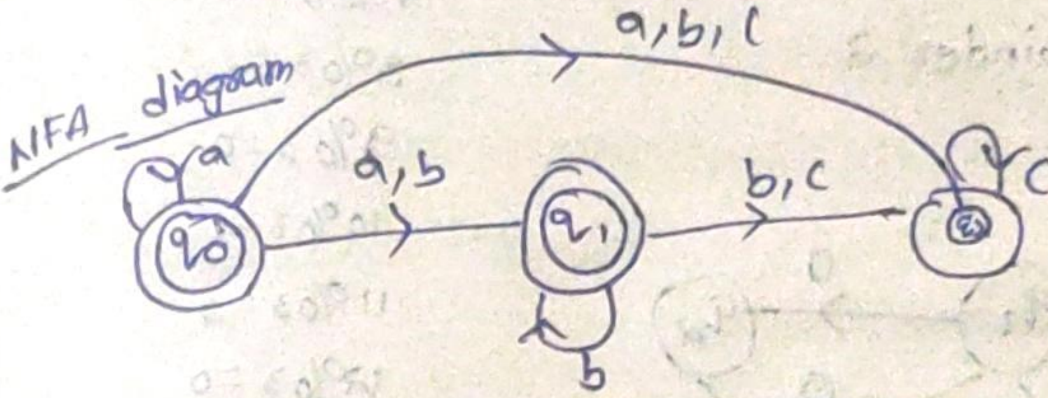
Same for

$\delta'(q_0, c)$

$\delta'(q_1, a)$, $\delta'(q_1, b)$, $\delta'(q_1, c)$

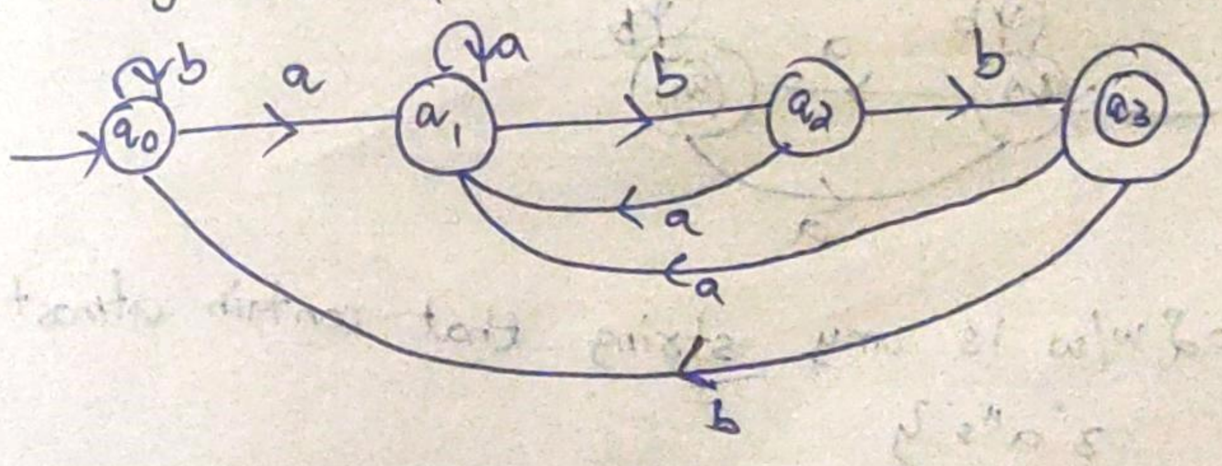
$\delta'(q_2, a)$, $\delta'(q_2, b)$, $\delta'(q_2, c)$

NFA diagram



(5) Describe a DFA to accept the strings a''s and b''s ending with "abb" over an alphabet $\Sigma = \{a, b\}$

Ans: Language (L) = {abb, aabb, babb, ababb - - - }



⑦ Demonstrate a DFA that any given decimal number is divisible by 3

Ans!

$q_0 \rightarrow$ remainder 0

$q_1 \rightarrow$ remaindr 1

$q_2 \rightarrow$ remainder 2

Reminders : 0 to 2

6 % 3 = 0

7 % 3 = 1

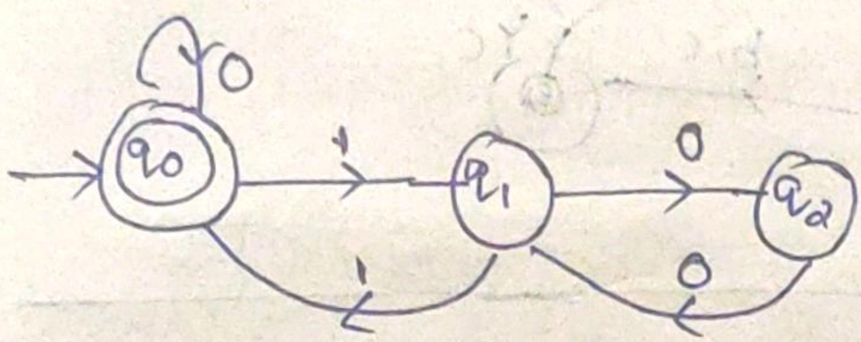
8 % 3 = 2

9 % 3 = 0

10 % 3 = 1

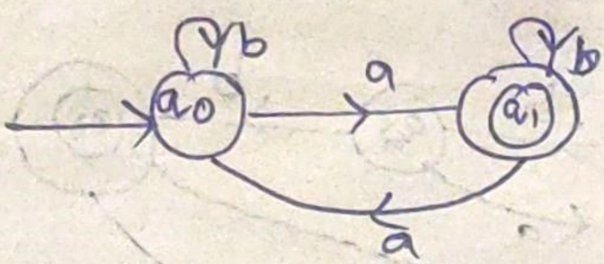
11 % 3 = 2

12 % 3 = 0



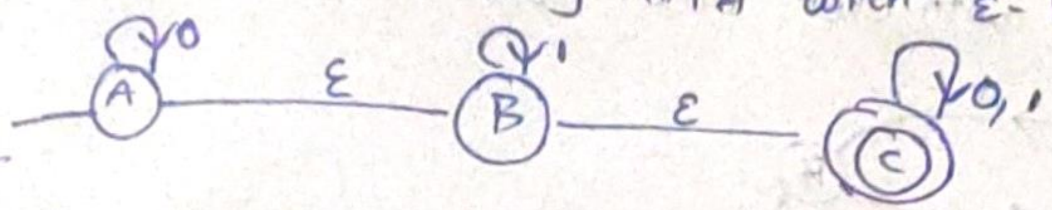
⑧ a) L = {w/w is any string that doesn't contain exactly two a's}

Ans: L = {a, b, ab, abb, aaab, - - - -}



b) L = {w/w is any string that contain atmost 3 a's}

(Q.) Convert the following NFA with ε-NFA



ε-NFA

δ	0	1	ε
A	A	Φ	B
B	Φ	B	C
C	C	C	Φ

ε-closure (A) = {A, B, C}
ε-closure (B) = {B, C}
ε-closure (C) = {C}

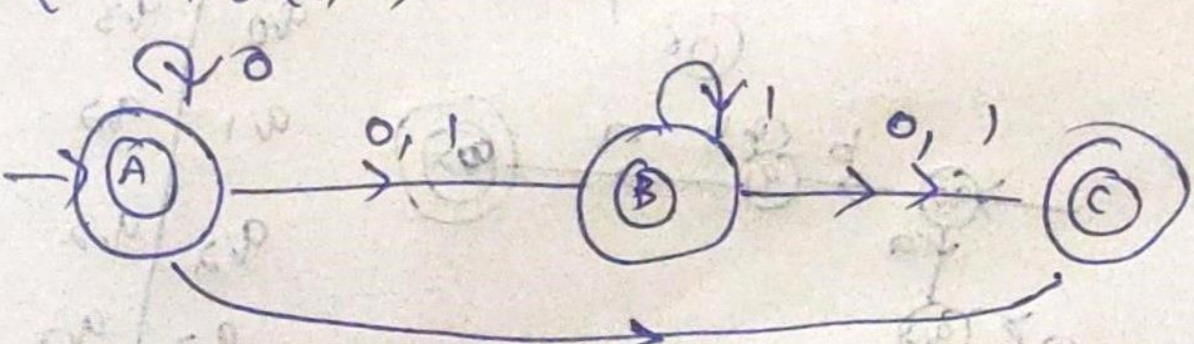
NFA

δ'	0	1
→A	{A, B, C}	{B, C}
*B	C	{B, C}
*C	C	C

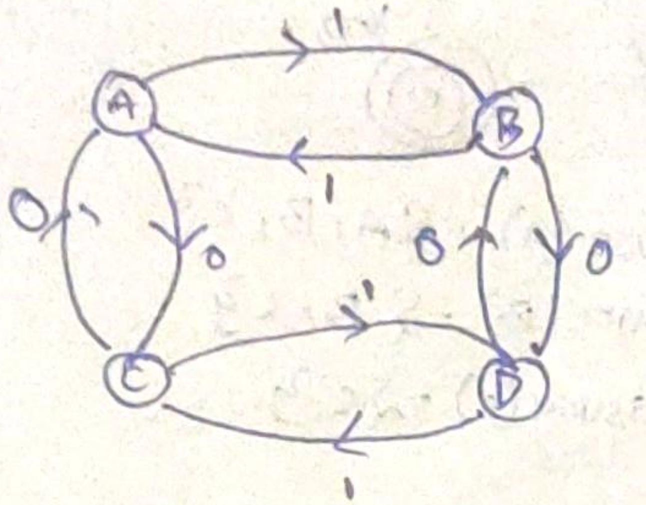
$\delta'(A,0) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(A,0)))$
$= \varepsilon\text{-closure}(\delta(\delta(A,0) \cup \delta(B,0) \cup \delta(C,0)))$
$= \varepsilon\text{-closure}(A \cup \phi \cup C)$
$= \varepsilon\text{-closure}(A) \cup \varepsilon\text{-closure}(C)$
$= \{A, B, C\} \cup \{C\}$
$= \{A, B, C\}$

$\delta'(A,1) = \delta(\delta(\delta(A,1)))$
$= \delta(\delta(\phi \cup B \cup C))$
$= \delta(B, C)$
$= \delta(B \cup C)$
$= \{B, C\} \cup \{C\}$
$= B, C$

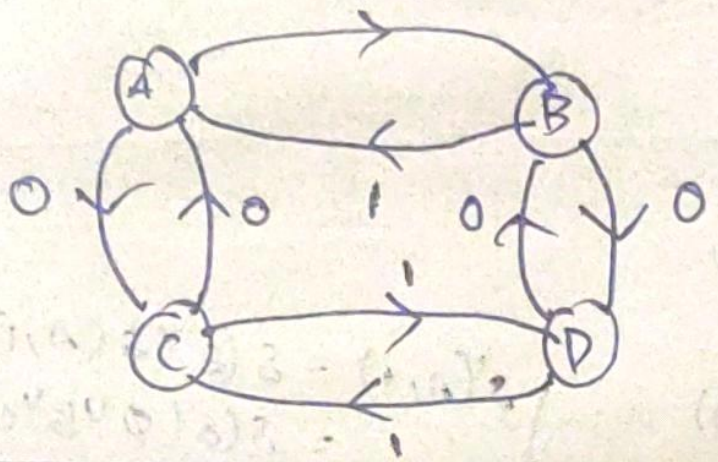
Same for
$\delta'(B,0)$, $\delta(B,1)$
$\delta'(C,0)$, $\delta'(C,1)$



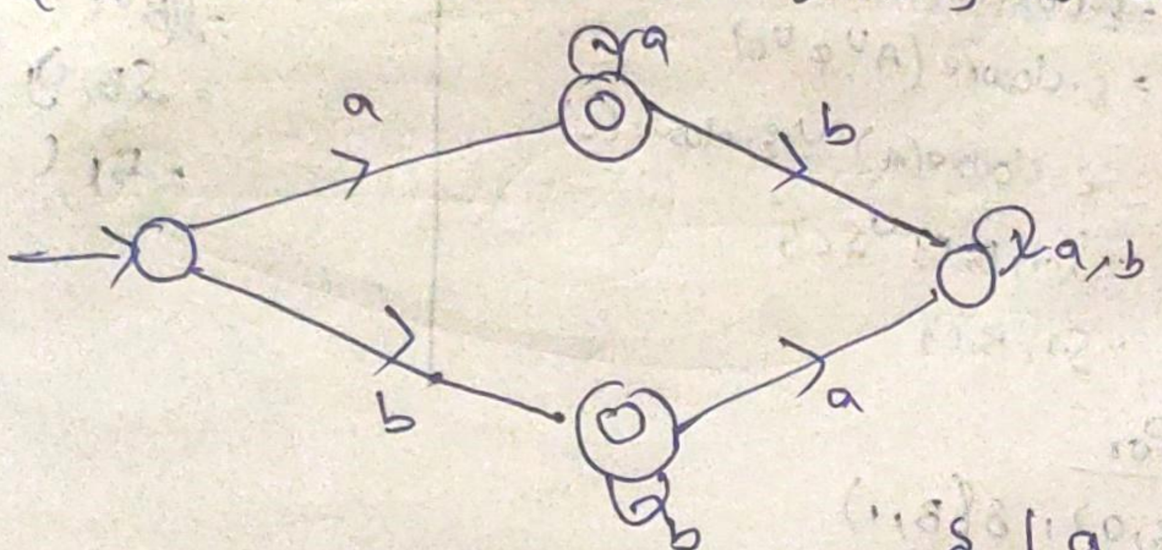
10) a) The string with even no.of 0's and odd no.of 1's



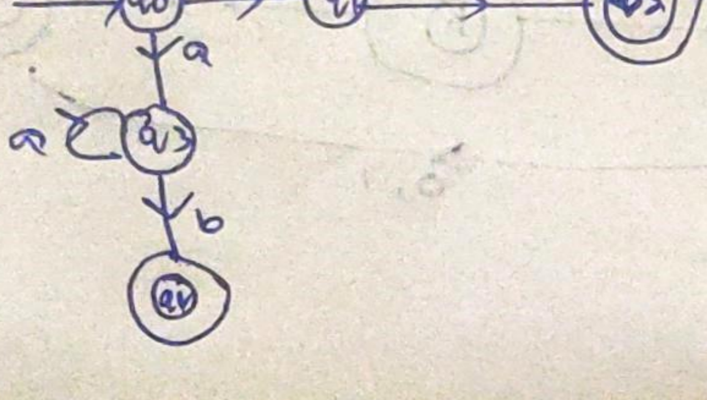
b) The string with odd no.of 0's and odd no.of 1's



(11) L = { w | w contains neither the substring ab nor ba }

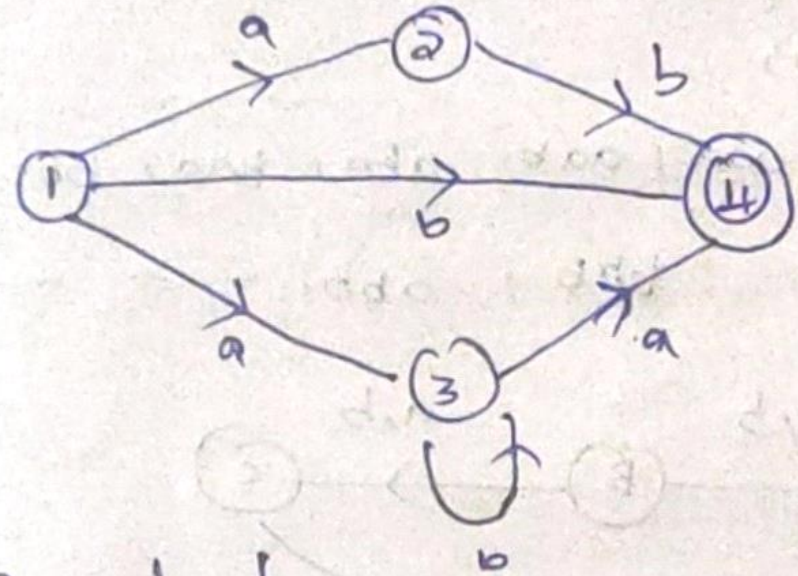


(or)



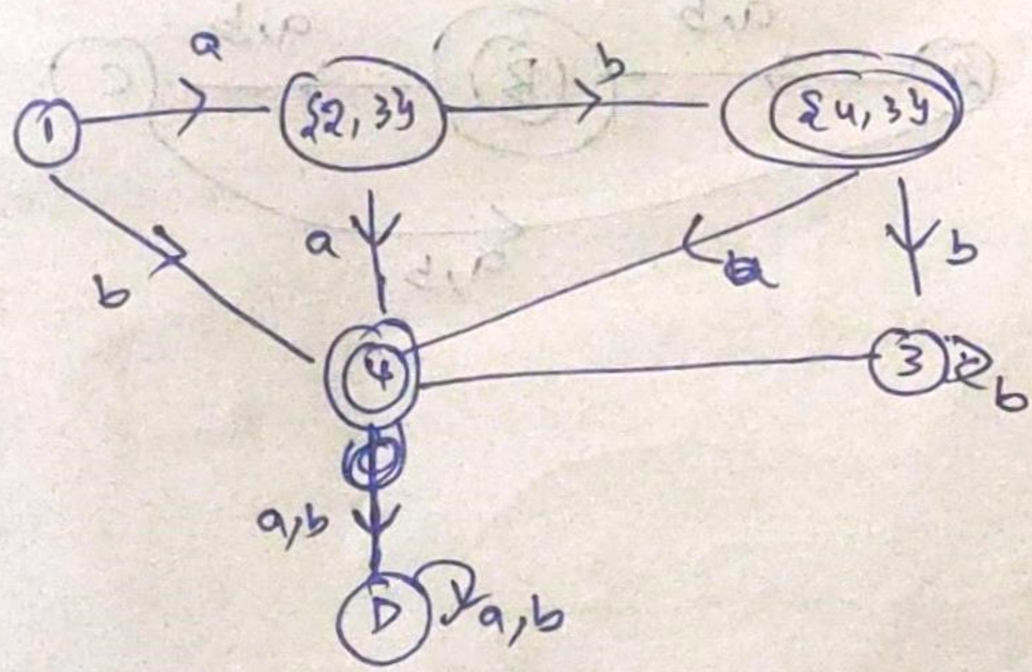
δ	a	b
q_0	q_3	q_1
q_1	q_2	q_1
q_2	q_2	q_3
q_3	q_3	q_4

12 Convert the following NFA into DFA



NFA	a	b
→1	{2,3}	{4}
2	φ	{4}
3	{4}	{3}
*4	φ	φ

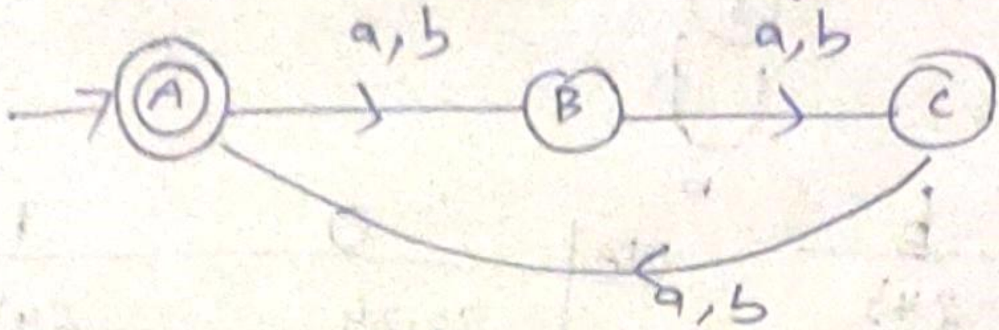
DFA	0	1
→1	{2,3}	{4}
{2,3}	{4}	{4,3}
*{4,3}	{4}	{3}
{3}	{4}	{3}
*{4}	φ	φ



(13) a) mod 3 = 0

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

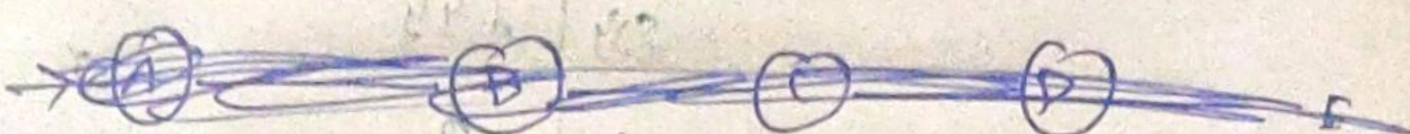
$L = \{0, aaa, aab, aba, baa, bbb, bba, bab, abb, - - -\}$

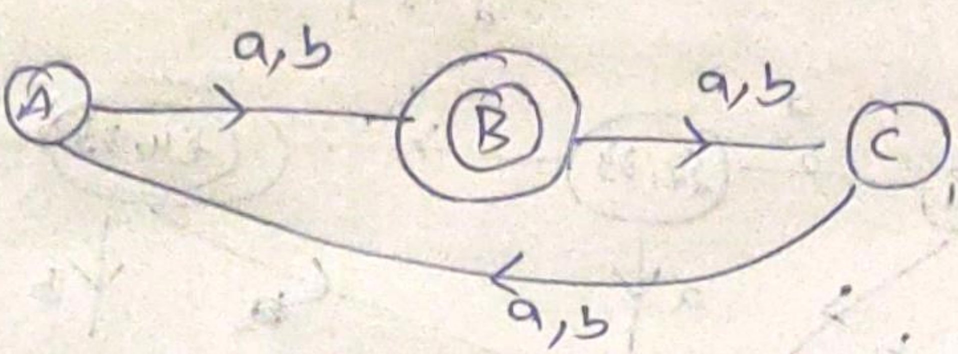


b) mod 3 = 1

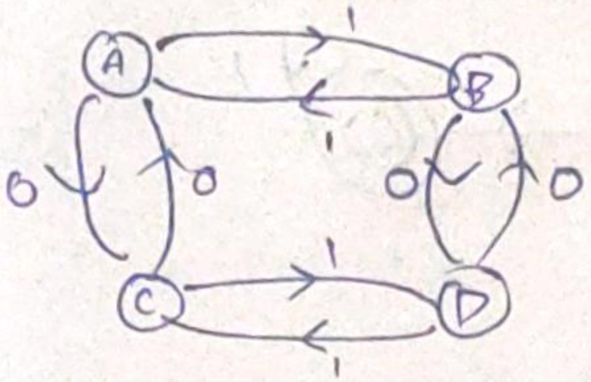
$\Sigma = \{a, b\}$

$L = \{aaaa, aabb, - - \}$

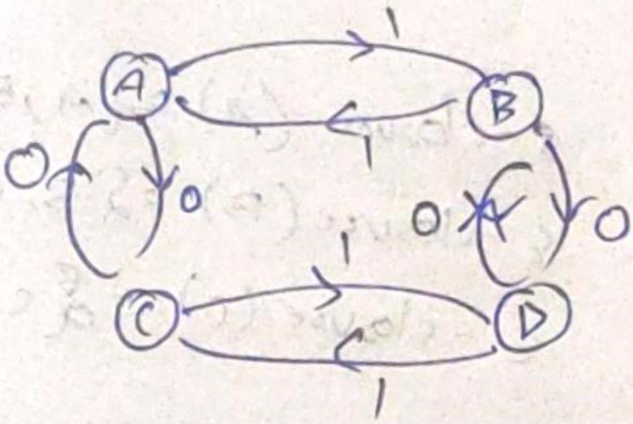




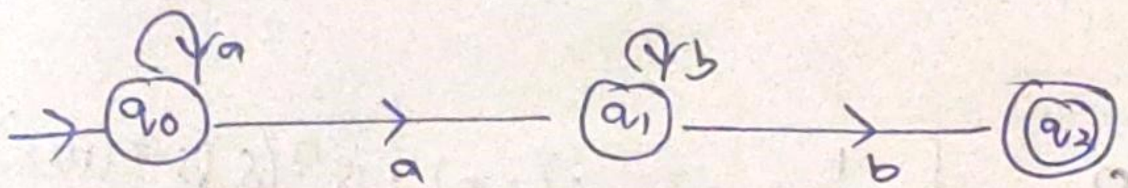
(14) a) even no.of 0's and even no.of 1's



b) odd no.of 0's and even no.of 1's



(15) NFA to DFA

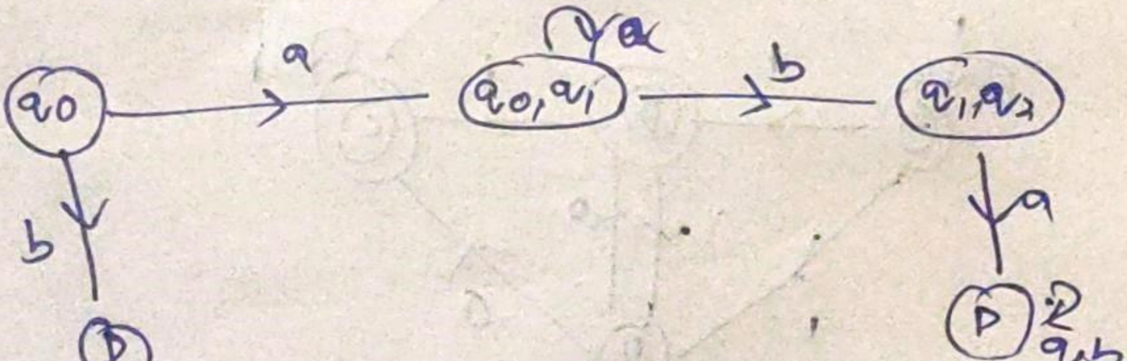


NFA

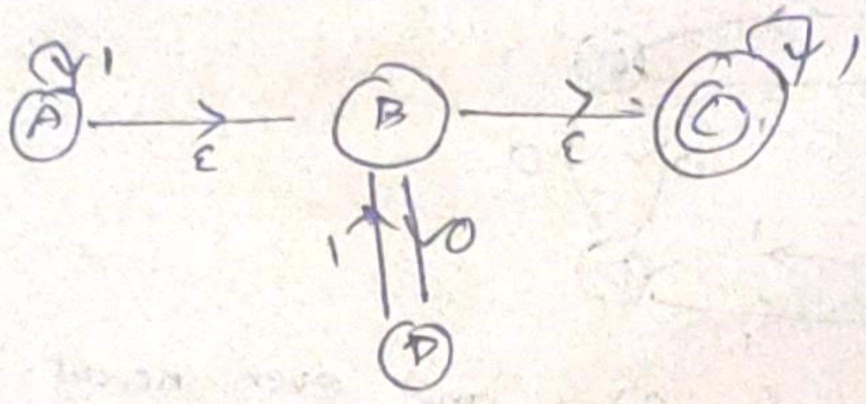
δ	a	b
$\rightarrow q_0$	$\{q_0, q_1\}$	ϕ
q_1	ϕ	$\{q_1, q_2\}$
q_2	ϕ	ϕ

DFA

	a	b
$\rightarrow q_0$	$\{q_0, q_1\}$	ϕ
$\{q_0, q_1\}$	$\{q_0, q_1\}$	$\{q_1, q_2\}$
$* \{q_1, q_2\}$	ϕ	$\{q_1, q_2\}$



(16) ε-NFA to NFA



ε-NFA

δ	0	1	ε
A	φ	A	B
B	φ	D	C
C	φ	C	φ
D	B	φ	φ

ε-closure (A) = {A, B, C}

ε-closure (B) = {B, C}

ε-closure (C) = {C}

NFA

δ'	0	1
→A	{φ}	{A, B, C, D}
B	{φ}	{C, D}
C	{φ}	{C}
D	{B, C}	{φ}

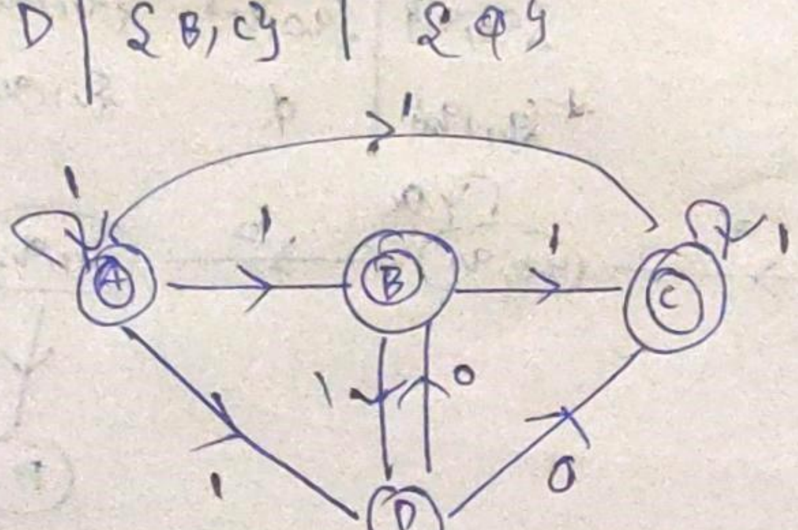
$\delta'(A,0) = \delta^\wedge(\delta(\delta^\wedge(A,\varepsilon)0)\varepsilon)$

$\delta^\wedge(\delta(A,B,C)0)\varepsilon)$

$\delta^\wedge(\delta(A,0) \cup \delta(B,0) \cup \delta(C,0)\varepsilon)$

$\delta^\wedge(\phi \cup \phi \cup \phi)\varepsilon$

ϕ



(17) same as (13) one

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(18) same as (16) one

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(19) starts with 01 and ends with 01