Page No.
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Assignment ⇒ 1.

Theory of Computation.

Ques-1) Given, $A = \{1, 2, 3, 4\}$ $B = \{2, 4, 3, 1\}$
Since, $\forall x \in A \exists x \in B$
Hence, both set A and B are equal.

2. $A = \{1, 2, 5, 7\}$ $n = 4$
Subsets of $A = 2^n = 2^4 = 16$
$\{\}, \{1\}, \{3\}, \{5\}, \{7\}, \{1,3\}, \{1,5\}, \{1,7\}, \{3,5\}$
$, \{3,5\}, \{5,7\}, \{1,3,5\}, \{1,3,7\}, \{1,5,7\}$
$, \{3,5,7\}, \{1,3,5,7\}.$

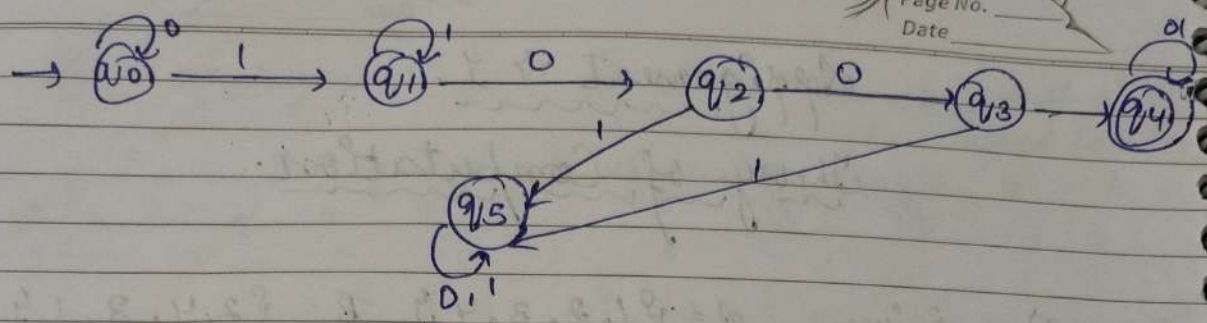
3. $A = \{1, 2, 3, 4, 5 \ldots\}$
$A = \{x \in N \mid x \geq 1\}$

4. Given, $A = \{1, 3, 5, 7, 9, 11\}$ $B = \{1, 2, 3, 13\}$
$A - B = \{5, 7, 9, 11\}$ $B - A = \{2, 13\}$

5. Given, $A = \{1, 3, 5\}$, $B = \{2, 4, 6\}$ $C = \{1, 5, 7\}$
$B \cup C = \{1, 2, 4, 5, 6, 7\}$
$A \cup (B \cup C) = \{1, 2, 3, 4, 5, 6, 7\}$

Ques3 = 1. $L = \{10, 0010, \ldots\}$

$Q = q_0, q_1, q_2, q_3, q_4, q$.
$\Sigma = \{a, b\}$
$q_0 = q_0$
$f = q_4$.

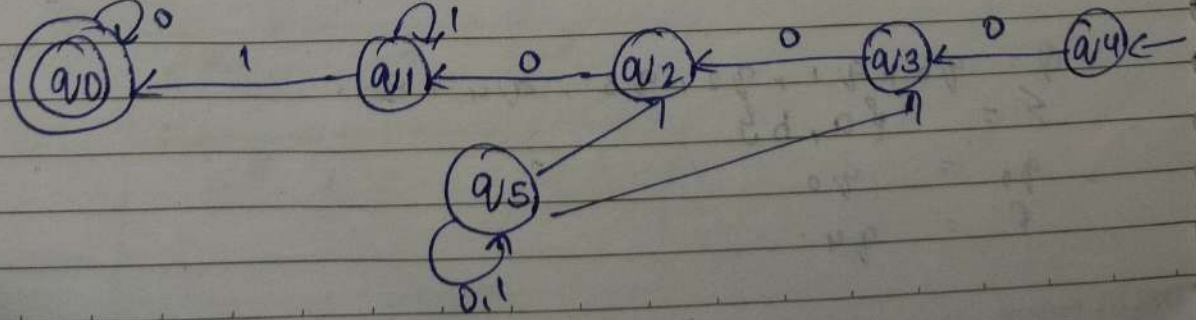


Transition functions :- $\delta(q_0, 0) = q_0$
$\delta(q_0, 1) = q_1$
$\delta(q_1, 0) = q_2$
$\delta(q_1, 1) = q_1$
$\delta(q_2, 0) = q_3$
$\delta(q_2, 1) = q_4$
$\delta(q_3, 0) = q_4$
$\delta(q_3, 1) = q_4$
$\delta(q_4, 0) = q_4$
$\delta(q_4, 1) = q_4$
$\delta(q_5, 0) = q_5$
$\delta(q_5, 1) = q_5$

Transition table.

States	Input	
	0	1
q_0	q_0	q_1
q_1	q_2	q_1
q_2	q_3	q_4
q_3	q_4	q_4
q_4	q_4	q_4
q_5	q_5	q_5

2.



3. Ve
b

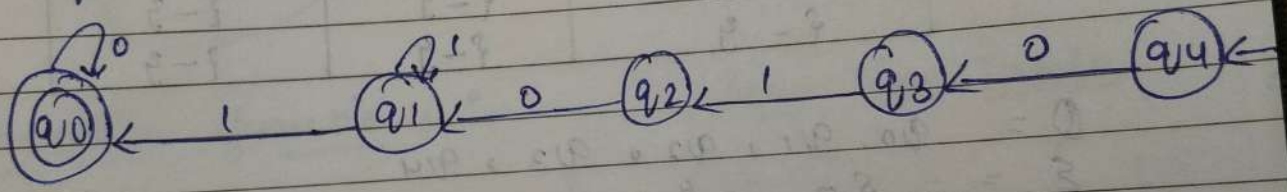
4.

3. Yes, it is a valid finite automation because it has :-
→ finite state q4
→ final state q0.

It is NFA (non deterministic finite automata) because from q0 there are 2 possible transitions on 1.
In DFA we have at most one transactions from each symbol.

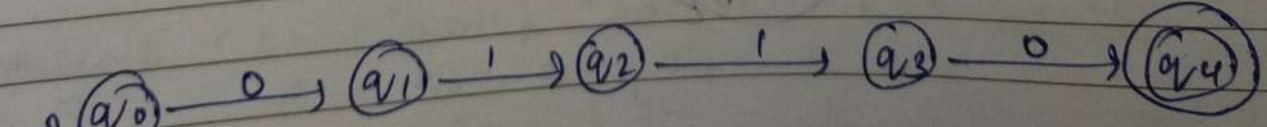
4. Step 1 - Remove unreachable states → q5 (no incoming edge, only self loop.

Step 2 : (Diagram)



Ques 4 Given,
string begins with 01
string ends with 10
L = {'1011O', '01111O', ---------- }

NFA
Q = q0, q1, q2, q3, q4
Σ = {0, 1}
q0 = q0
F = q4



Transition Function :-

$\delta : (q_0, 0) = q_1$
$\delta : (q_1, 1) = q_2$
$\delta : (q_2, 1) = q_3$
$\delta : (q_3, 0) = q_4$

Transition Table :-

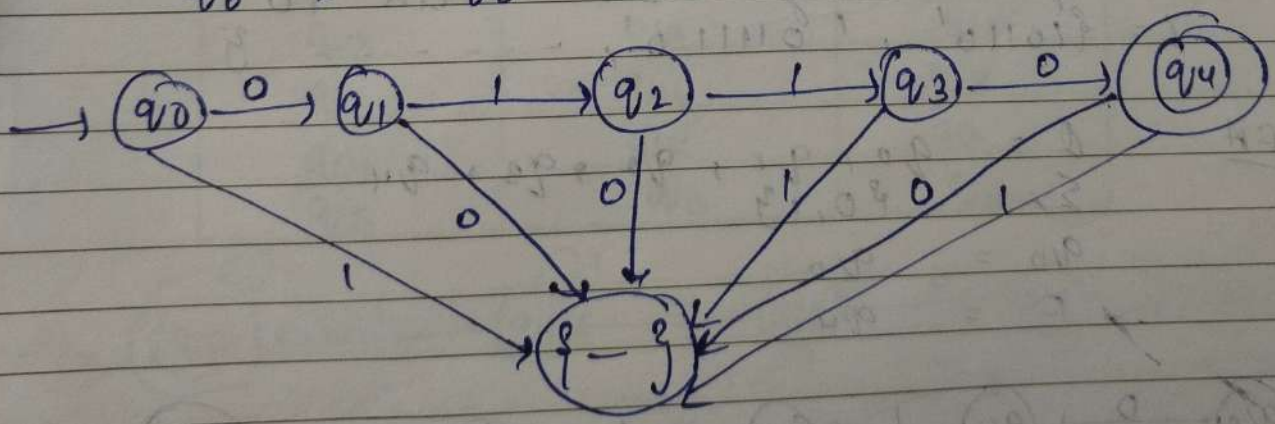
State \ Input	0	1
q_0	q_1	-
q_1	-	q_2
q_2	-	q_3
q_3	q_4	-
q_4	-	-

DFA

Transition Table ⇒

State \ Input	0	1
q_0	q_1	{-}
q_1	{-}	q_2
q_2	{-}	q_3
q_3	q_4	{-}
q_4	{-}	{-}
{-}	{-}	{-}

$Q = q_0, q_1, q_2, q_3, q_4$
$\Sigma = \{0, 1\}$
$F = q_4$
$q_0 = q_0$



DELTA Notebook

Transition functions.

$\delta: (q_0, 0) = q_1$
$\delta: (q_0, 1) = \{-\}$
$\delta: (q_1, 0) = \{-\}$
$\delta: (q_1, 1) = q_2$
$\delta: (q_4, 0) = \{-\}$
$\delta: (q_2, 0) = \{-\}$
$\delta: (q_2, 1) = q_3$
$\delta: (q_3, 0) = q_4$
$\delta: (q_3, 1) = \{-\}$
$\delta: (q_4, 1) = \{-\}$

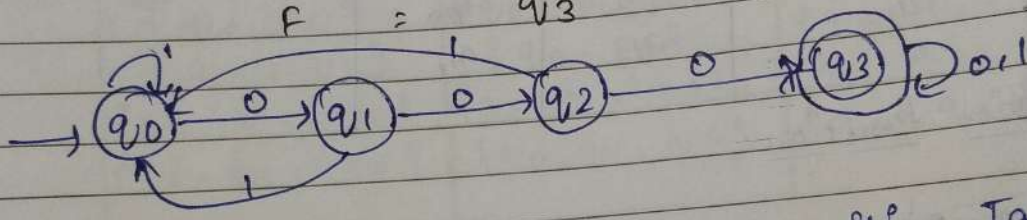
Ques 5 = given, $L = \{000, 1000, 1001, ----\}$

$Q = q_0, q_1, q_2, q_3$

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

$q_0 = q_0$

$F = q_3$



Transition functions :

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

Transition Table

States \ Input	0	1
q_0	q_1	q_1
q_1	q_2	q_0
q_2	q_3	q_0
q_3	q_3	q_3

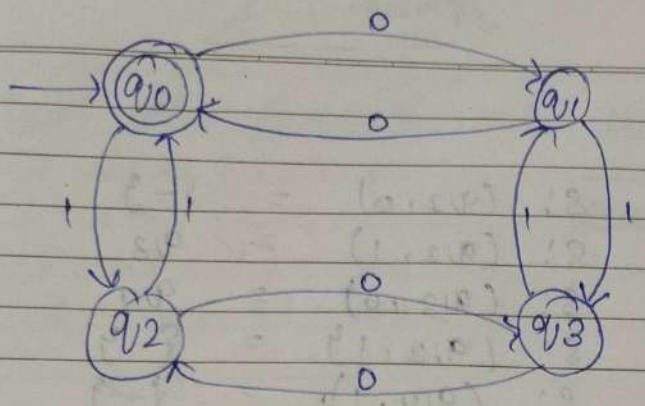
Ques-6 $L = \{$"0011", "00110011", ---- $\}$

$Q = q_0, q_1, q_2, q_3$

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

$q_0 = q_0$

$F = q_0$



Transition table :-

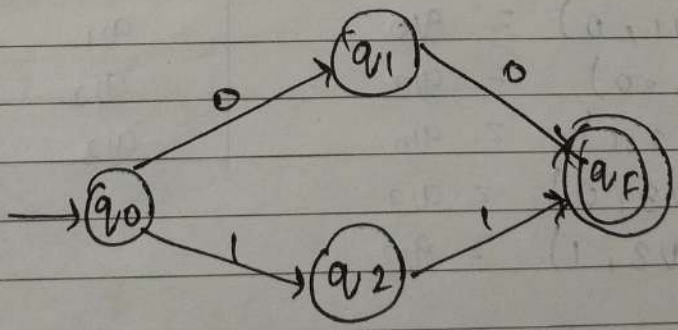
State \ Input	0	1
q_0	q_1	q_2
q_1	q_0	q_3
q_2	q_3	q_0
q_3	q_2	q_1

Transition function.

$\delta : (q_0, 0) = q_1$
$\delta : (q_1, 0) = q_0$
$\delta : (q_2, 0) = q_3$
$\delta : (q_3, 0) = q_2$

$\delta : (q_0, 1) = q_2$
$\delta : (q_1, 1) = q_3$
$\delta : (q_2, 1) = q_0$
$\delta : (q_3, 1) = q_1$

Ques-7 Given,
NFA :-

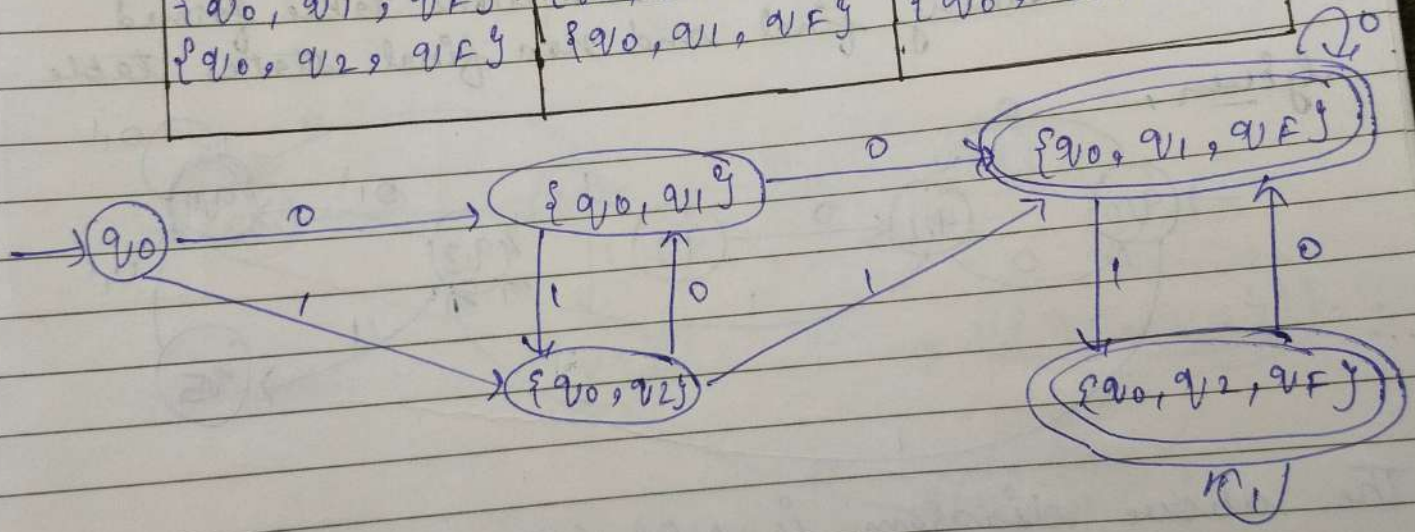


NFA transition table :-

States / Input	0	1
q_0	$\{q_0, q_1\}$	$\{q_0, q_2\}$
q_1	q_F	–
q_2	–	q_F
q_F	q_F	q_F

DFA : transition table :-

States / Input	0	1
q_0	$\{q_0, q_1\}$	$\{q_0, q_2\}$
$\{q_0, q_1\}$	$\{q_0, q_1, q_F\}$	$\{q_0, q_2\}$
$\{q_0, q_2\}$	$\{q_0, q_1\}$	$\{q_0, q_1, q_F\}$
$\{q_0, q_1, q_F\}$	$\{q_0, q_1, q_F\}$	$\{q_0, q_2, q_F\}$
$\{q_0, q_2, q_F\}$	$\{q_0, q_1, q_F\}$	$\{q_0, q_2, q_F\}$



For DFA :-

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

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

$q_0 = q_0$

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

Transition functions.

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

$\delta:(\{q_0,q_1,\}0) = \{q_0,q_1,q_F\}$ $\delta:(\{q_0,q_1\},1) = \{q_0,q_2\}$

$\delta:(\{q_0,q_2\},0) = \{q_0,q_1\}$ $\delta:(\{q_0,q_2\},1) = \{q_0,q_1,q_F\}$

$\delta:(\{q_0,q_1,q_F,0) = \{q_0,q_1,q_F\}$ $\delta:(\{q_0,q_1,q_F\},1) = \{q_0,q_2,q_F\}$

$\delta:(\{q_0,q_2,q_F,0\} = \{q_0,q_2,q_F\}$ $\delta:(\{q_0,q_2,q_F\},1\} = \{q_0,q_2,q_F\}$

Ques-2

Step 1 = Remove the unreachable states

Step 2 = Create the transition table of given DFA

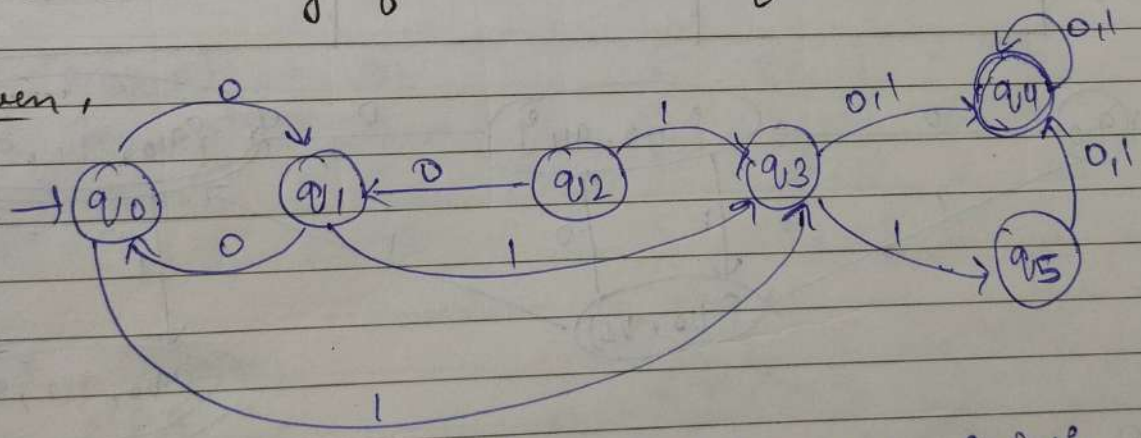
step 3 = create the transition table for non-final states

step 4 = create the transition table for final states

step 5 = Remove duplicate rows from both the tables

step 6 = Redraw DFA with transitions table formed after Combining final and non final states table.

Given,



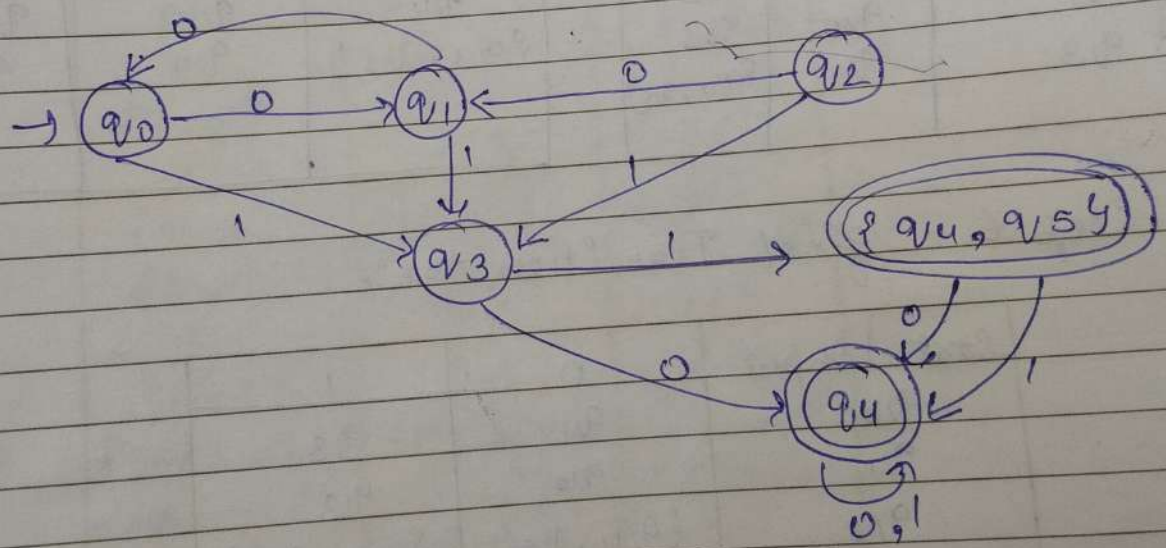
The above diagram is NFA (Non deterministic finite automata)

NFA transition Table :-

States \ Input	0	1
→ q_0	q_1	q_3
q_1	q_0	q_3
q_2	q_1	q_3
q_3	q_4	$\{q_4, q_5\}$
((q_4))	q_4	q_4
q_5	q_4	q_4

DFA Transition table :-

States \ Input	0	1
→ q_0	q_1	q_3
q_1	q_0	q_3
q_3	q_4	$\{q_4, q_5\}$
q_4	q_4	q_4
$\{q_4, q_5\}$	$\{q_4\}$	q_4
q_2	q_1	q_3



Step 1 - Remove unreachable states
q_2 is unreachable so we remove it

Step 2. DFA transition table:

States \ Input	0	1
q_0	q_1	q_3
q_1	q_0	q_3
q_3	q_4	$\{q_4, q_5\}$
q_4	q_4	q_4
$\{q_4, q_5\}$	q_4	q_4

Step-5 Remove duplicate rows.

q_4 and $\{q_4, q_5\}$ are duplicate rows so we replace q_4 with $\{q_4, q_5\}$ from final states table

Step 3:- Transition Table (Non-final states)

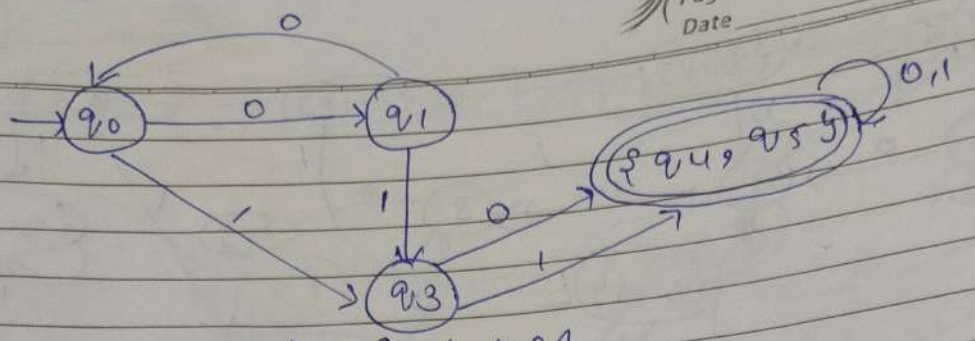
States \ Input	0	1
q_0	q_1	q_3
q_1	q_0	q_3
q_3	q_4	$\{q_4, q_5\}$

Step-4 - Transition Table (final State)

States \ Input	0	1
q_4	q_4	q_4
$\{q_4, q_5\}$	q_4	q_4

Step 6 - final Transition table

State \ Input	0	1
q_0	q_1	q_3
q_1	q_0	q_3
q_3	$\{q_4, q_5\}$	$\{q_4, q_5\}$
$\{q_4, q_5\}$	$\{q_4, q_5\}$	$\{q_4, q_5\}$



Minimised DFA.

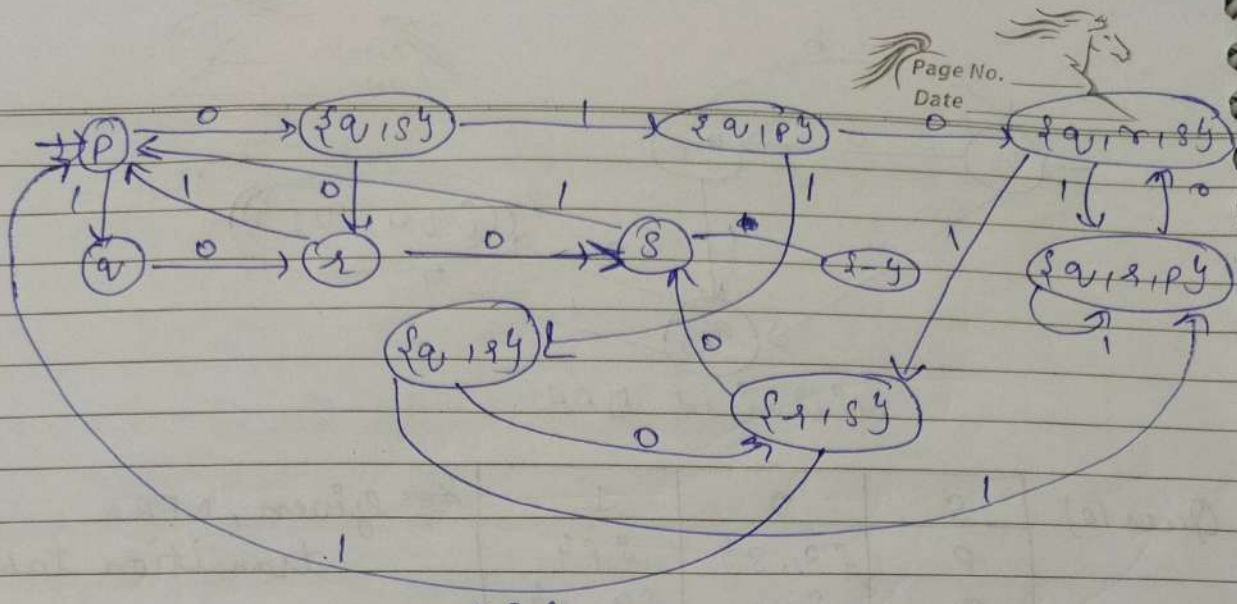
Ques 10)

S	0	1
P	{q, s}	{p}
q	{r}	{q, r}
r	{s}	{p}
s	-	{p}

⇐ given, NFA transition table

DFA transition table :-

S	0	1
p	{q, s}	{q}
q	{r}	{q, r}
{q, s}	{r, s}	{q, p}
s	{s}	{p}
{q, r}	{r, s}	{q, r, p}
{q, p}	{r, q, s}	{q, r, p}
s	{-}	{p}
{r, s}	{s}	{p}
{q, r, s}	{r, s, q}	{q, s, p}
{r, q, s}	{s, r}	{p, q, r}
{-}	{-}	{-}



DFA

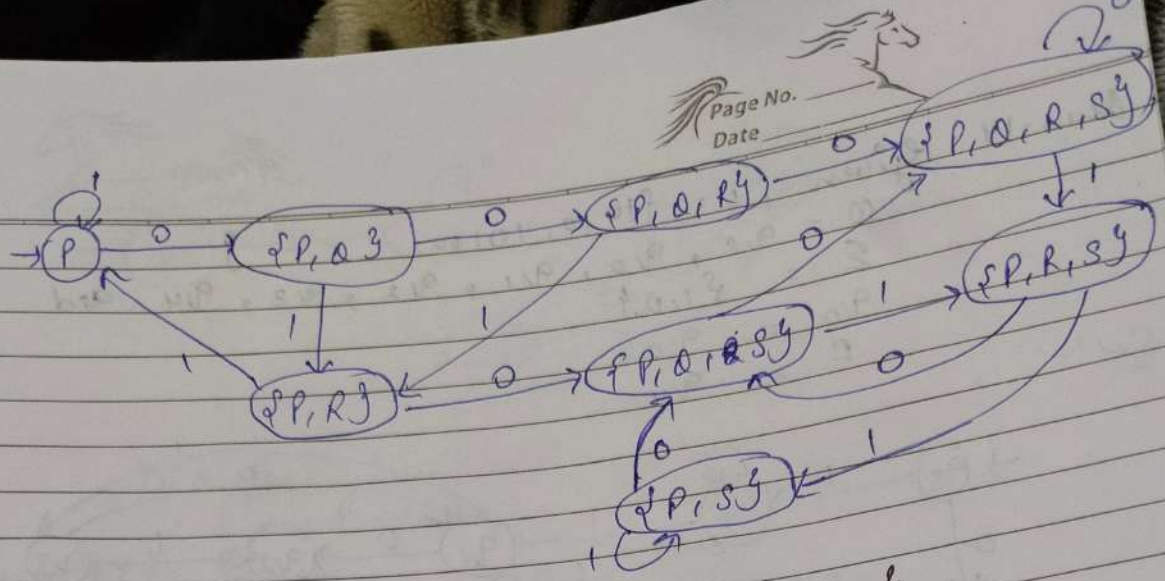
Ques-11) Given

NFA transition Table :-

S	0	1
P	{P, Q}	P
Q	R	R
R	S	-
S	S	S

DFA Transition Table :-

S	0	1
{P}	{P, Q}	{P, Q}
{P, Q}	{P, Q, R}	{P, R}
{P, R}	{Q, Q, S}	{P, S}
{P, Q, R}	{P, Q, R, S}	{P, R, S}
{P, Q, S}	{P, Q, R, S}	{P, R, S}
{P, R, S}	{P, Q, S}	{P, S}
{P, S}	{P, Q, S}	{P, S}
{P, Q, R, S}	{P, Q, R, S}	{P, R, S}



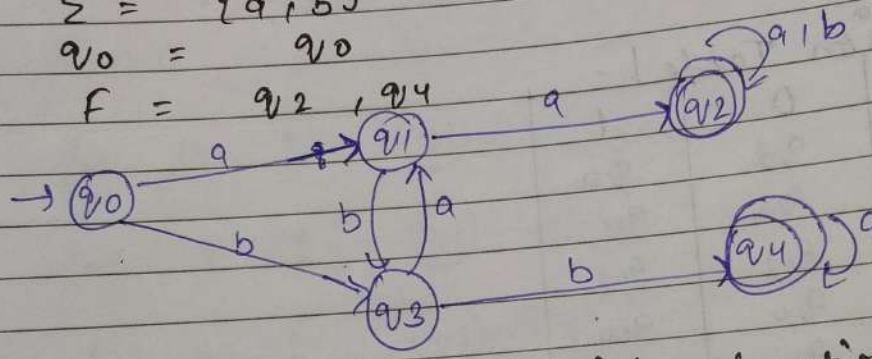
Ques-13 $L = \{"aa", "bb", \text{---------} \}$

$Q = q_0, q_1, q_2, q_3, q_4$

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

$q_0 = q_0$

$F = q_2, q_4$



Transition Table:

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

Transition functions:

$\delta(q_0, a) = q_1$

$\delta(q_0, b) = q_2$

$\delta(q_1, a) = q_2$

$\delta(q_1, b) = q_3$

$\delta(q_2, a) = q_2$

$\delta(q_2, b) = q_2$

$\delta(q_3, a) = q_1$

$\delta(q_3, b) = q_4$

$\delta(q_4, a) = q_4$

$\delta(q_4, b) = q_4$

Ques-14 Given, $L = \{1010, 101100, ---\}$

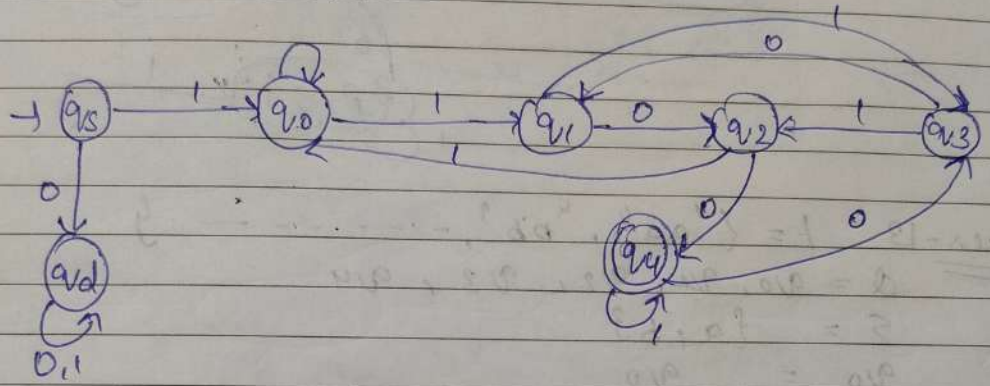
$Q = q_S, q_0, q_1, q_2, q_3, q_4, q_d$

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

$q_0 = q_0$

$f = q_4$

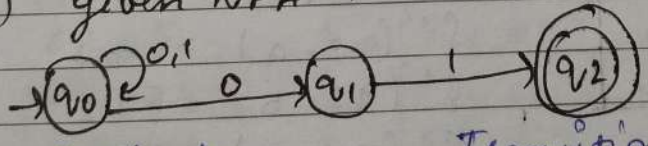
Sol:-



Transition Table:-

δ	0	1
→ q_S	q_d	q_0
q_0	q_0	q_1
q_1	q_2	q_3
q_2	q_4	q_0
q_3	q_1	q_2
(*) q_4	q_3	q_4
q_d	q_d	q_d

Ques-15) Given NFA :-



Transition table for NFA

δ	0	1
→ q_0	$\{q_0, q_1\}$	$\{q_0\}$
q_1	-	$\{q_2\}$
(*) q_2	-	-

⇒

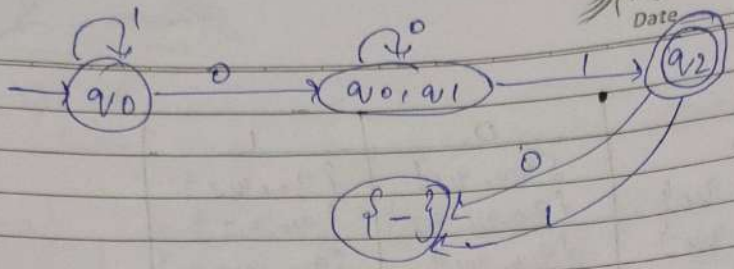
Transition table for DFA.

δ	0	1
→ q_0	$\{q_0, q_1\}$	$\{q_0\}$
$\{q_0, q_1\}$	$\{q_0, q_1\}$	$\{q_0, q_2\}$
q_2 (*)	$\{-\}$	$\{-\}$

Ques-1

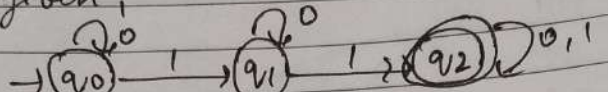
Ques

DELTA Notebook



DFA for given NFA.

Ques-19) Given,



Checking for 101101

for 0 : $q_0 \xrightarrow{0} q_1$

for 1 : $q_1 \xrightarrow{1} q_2$

for 1 : $q_2 \xrightarrow{1} q_2$

for 0 : $q_2 \xrightarrow{0} q_2$

for 1 : $q_2 \xrightarrow{1} q_2$

Hence, the given automata is acceptable for given string

Ques-20 given, NFA

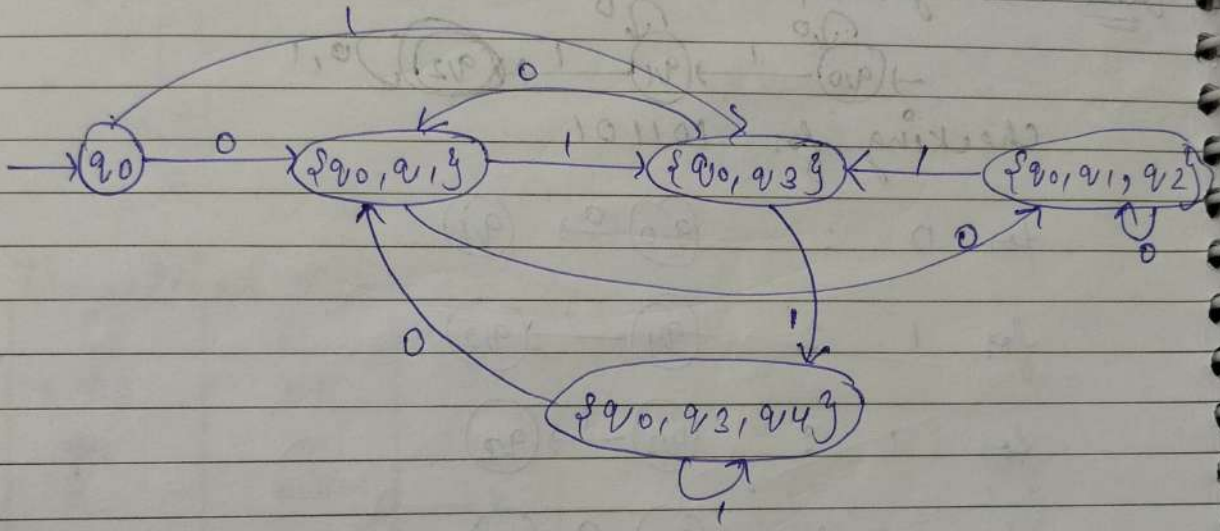
δ	0	1
q_0	$\{q_0, q_1\}$	$\{q_0, q_3\}$
q_1	$\{q_2\}$	ϕ
q_2	ϕ	ϕ
q_3	ϕ	$\{q_4\}$
q_4	ϕ	ϕ

DFA

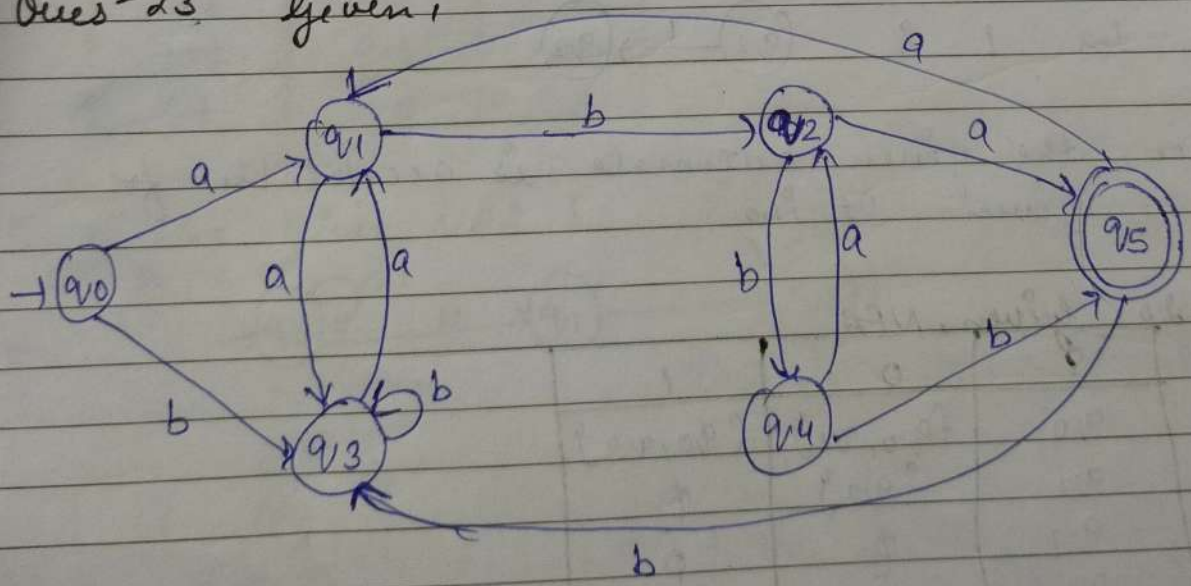
S	0	1
q_0	$\{q_0, q_1\}$	$\{q_0, q_3\}$
$\{q_0, q_1\}$	$\{q_0, q_1, q_2\}$	$\{q_0, q_2\}$
$\{q_0, q_3\}$	$\{q_0, q_1\}$	$\{q_0, q_3, q_4\}$
$\{q_0, q_1, q_2\}$	$\{q_0, q_1, q_2\}$	$\{q_0, q_2\}$
$\{q_0, q_3, q_4\}$	$\{q_0, q_1\}$	$\{q_0, q_3, q_4\}$

step-1)

step-2



Ques-23 Given,



DELTA Notebook

Step-1) Remove unreachable states
There are no unreachable states

Step-2) Transition Table for given DFA:

δ	a	b
→ q0	q1	q3
q1	q3	q2
q2	q5	q4
q3	q1	q3
q4	q2	q5
(q5)	q1	q3

Step-3) Non-final state transition table

δ	a	b
→ q0	q1	q3
q1	q3	q2
q2	q5	q4
q3	q1	q3
q4	q2	q5

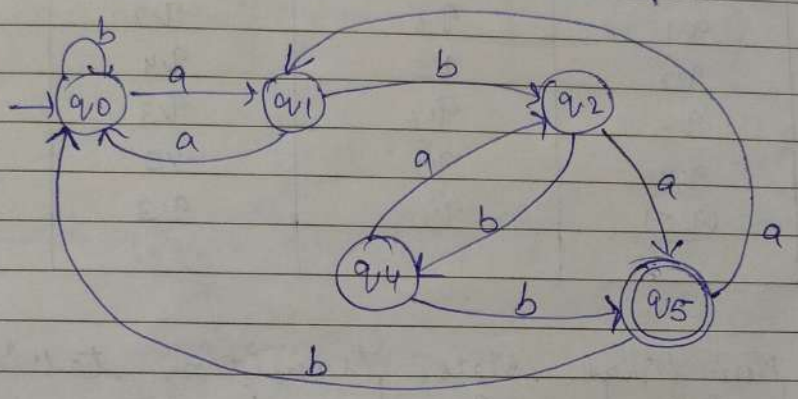
Step-4) final state transition table

δ	a	b
q5	q1	q3

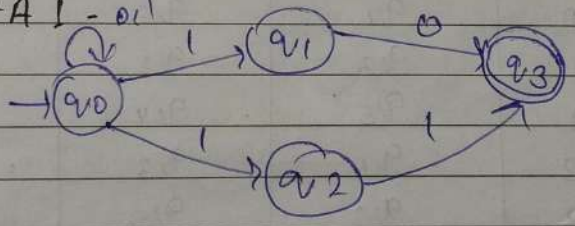
Step-5) Remove duplicate rows.
q0, q3 are duplicate so we replace q3 with q0 and remove q3 row.

Step-6) Final transition Table.

δ	a	b
→ q_0	q_1	q_0
q_1	q_0	q_2
q_2	q_5	q_4
q_4	q_2	q_5
(q_5)	q_1	q_0



Ques 22 :- NFA 1-01

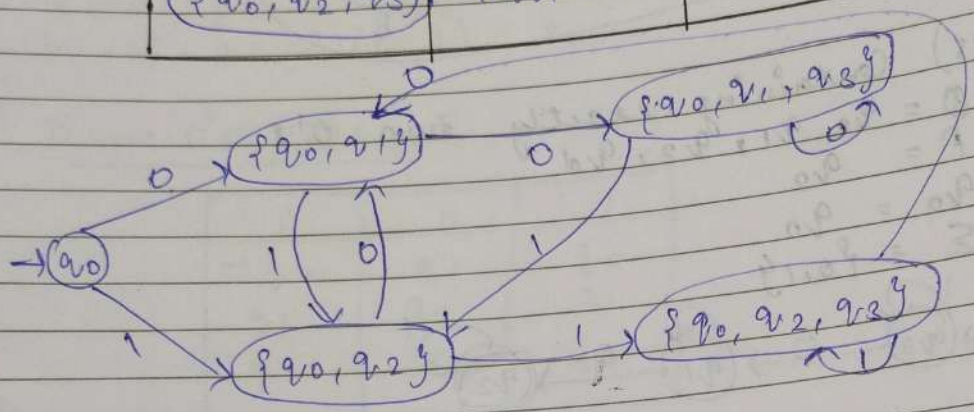


Transition Table :-

δ	0	1
→ q_0	q_1	$\{q_0, q_2\}$
q_1	q_3	—
q_2	—	q_3
q_3	—	—

Transition table for DFA :-

δ	0	1
→ q_0	$\{q_0, q_1\}$	$\{q_0, q_2\}$
$\{q_0, q_1\}$	$\{q_0, q_1, q_3\}$	$\{q_0, q_2\}$
$\{q_0, q_2\}$	$\{q_0, q_1\}$	$\{q_0, q_2, q_3\}$
$\{q_0, q_1, q_3\}$	$\{q_0, q_1, q_3\}$	$\{q_0, q_2\}$
$\{q_0, q_2, q_3\}$	$\{q_0, q_1\}$	$\{q_0, q_2, q_3\}$



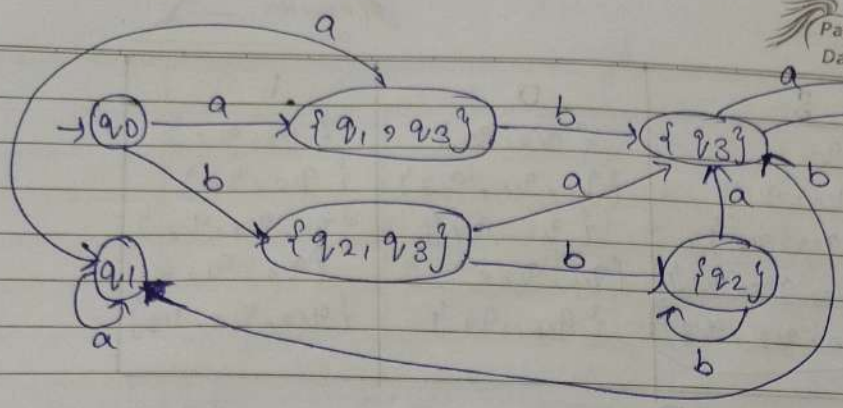
Ques-24)

δ	a	b
→ q_0	$\{q_1, q_3\}$	$\{q_2, q_3\}$
q_1	q_1	q_3
q_2	q_3	q_2
q_3	–	–

⟸ NFA Table.

Now, the DFA Table -

δ	a	b
→ $\{q_0\}$	$\{q_1, q_3\}$	$\{q_2, q_3\}$
$\{q_1, q_3\}$	$\{q_1\}$	$\{q_3\}$
$\{q_2, q_3\}$	$\{q_3\}$	$\{q_2\}$
$\{q_3\}$	$\{-\}$	$\{-\}$
$\{q_2\}$	$\{q_3\}$	$\{q_2\}$
$\{q_1\}$	$\{q_1\}$	$\{q_3\}$



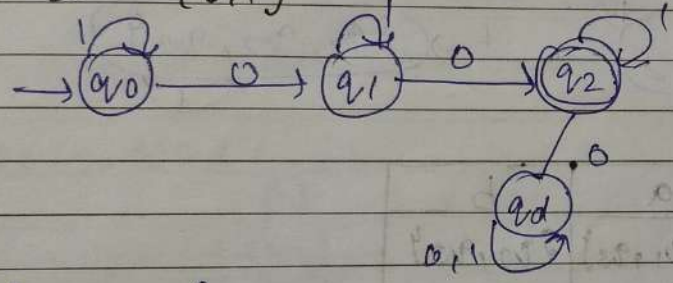
Ques-25) Containing exactly two 0's

(i) $Q = q_0, q_1, q_2, q_d$

$F = q_2$

$q_0 = q_0$

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



Transition function :-

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

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

$\delta : (q_2, 0) = q_d$ $\delta : (q_2, 1) = q_2$

Transition table :-

δ	0	1
$\rightarrow q_0$	q_1	q_0
q_1	q_2	q_1
q_2	q_d	q_2

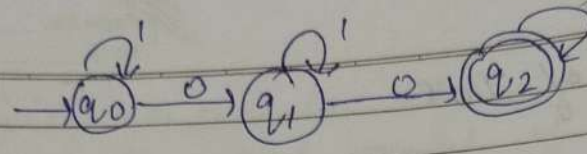
(ii) Containing atleast two 0's.

$Q :- q_0, q_1, q_2$

$F = q_2$

$q_0 = q_0$

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



Transition function:-

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

Transition table

δ	0	1
$\rightarrow q_0$	q_1	q_0
q_1	q_2	q_1
q_2	q_2	q_2