Finite Automaton with output

Moore — Mealey

(I) Moore machine

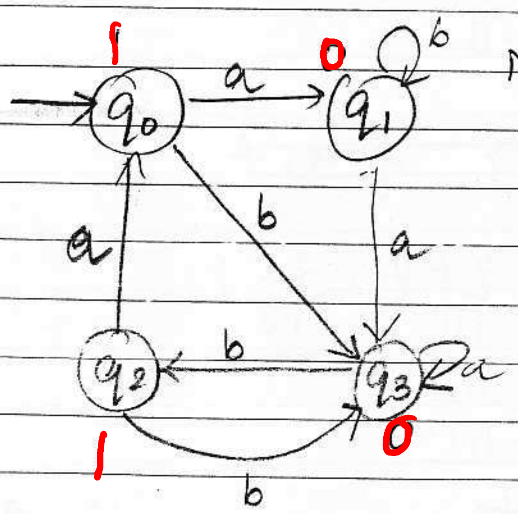
It has six tupples. Accepting state will not be one of them because for all input there should be an output. There is no place for rejection.

$$M = (Q, \Sigma, \Delta, \delta, \lambda, q_0)$$

$$\delta : Q \times \Sigma \rightarrow Q$$

Σ : input alphabets
Δ : output alphabets
δ : Transistion funct^n.
λ : output transition fun^c
q_0 : starting state

eg:



$$M = (\{q_0, q_1, q_2, q_3\}, \{a, b\}, \{0, 1\}, \delta, \lambda, q_0)$$

$\lambda(q_0) = 1$
$\lambda(q_1) = 0$
$\lambda(q_2) = 1$
$\lambda(q_3) = 0$

Q \ Σ	a	b	λ
→ q_0	q_1	q_3	1
q_1	q_3	q_1	0
q_2	q_0	q_3	1
q_3	q_3	q_2	0

i/p bba
o/p ?

Sol: $\rightarrow q_0 \xrightarrow{b} q_3 \xrightarrow{b} q_2 \xrightarrow{a} q_0$

1 0 1 1

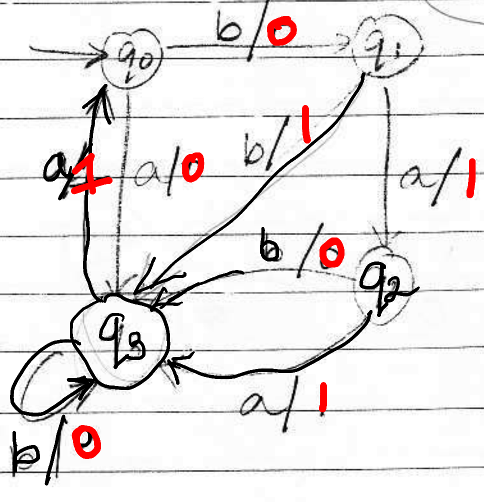
∴ o/p: 1011

Note: If the i/p sequence is of length 'n', it produces the o/p sequence of length 'n+1' because the starting state is associated.

Moore machine can produce o/p for ε string and that o/p symbol is associated with the start state.

Mealy machine: o/p symbol is associated with each transition

Q:



$$M = (\{q_0, q_1, q_2, q_3\}, \{a, b\}, \{0, 1\}, \delta, \lambda, q_0)$$

$\lambda(q_0, a) = 0$
$\lambda(q_0, b) = 0$
$\lambda(q_1, a) = 1$
$\lambda(q_1, b) = 1$
$\lambda(q_2, a) = 1$
$\lambda(q_2, b) = 0$
$\lambda(q_3, a) = \cancel{0}1$
$\lambda(q_3, b) = 0$

here every transition and not state has a output alphabet associated with it.

$\boxed{\lambda : Q \times \Sigma \rightarrow \Delta}$ ← output function of mealey machine.

	a		b	
Q	NS	o/p	Next state	output symbol.
$\rightarrow q_0$	q_3	0	q_1	0
q_1	q_2	1	q_3	1
q_2	q_3	1	q_3	0
q_3	q_0	$\cancel{0}1$	q_3	0

eg: baba : i/p
o/p = ?

$$\rightarrow q_0 \xrightarrow{b} q_1 \xrightarrow{a} q_2 \xrightarrow{b} q_3 \xrightarrow{a} q_0$$

0 1 0 $\cancel{0}$1

$\therefore$ o/p = 0100

Conslusion: If the no. of i/p symbols is 'n' then the o/p symbol is ~~n+1~~ n symbols.

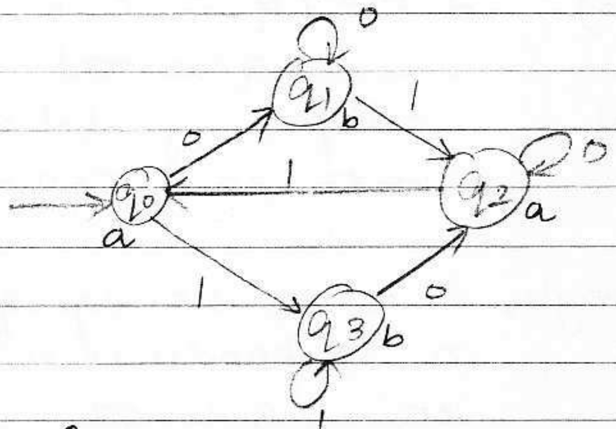
* Comparison of moore and mealey m/c.

Moore	Mealey
1. It is a DFA with o/p	1. It is a DFA with o/p
2. $M=(Q, \Sigma, \Delta, \delta, \lambda, q_0)$ $\lambda : Q \to \Delta$ Here output symbol associated with state.	2. $M=(Q, \Sigma, \Delta, \delta, \lambda, q_0)$ $\lambda : Q \times \Sigma \to \Delta$ output symbol associated with each transition.
3. For a string of length of n, it produces output string of length n+1	3. For a string of length n, it produces output string of length n.
4. It produces o/p for NULL string	4. It doesn't produces o/p for NULL string.
5. Draw a moore machine eg: take a string and give corresponding o/p	5. → Same.

* Conversion from Moore machine to Mealey machine.

To convert moore machine to mealey m/c, you need to ~~ano~~ associate output symbol of a given state to all incoming transitions to that state.

eg: convert the foll. to mealey



Sol: $M = (\{q_0, q_1, q_2, q_3\}, \{0,1\}, \{a,b\}, \delta, \lambda, q_0)$

given $\lambda : Q \rightarrow \Delta$

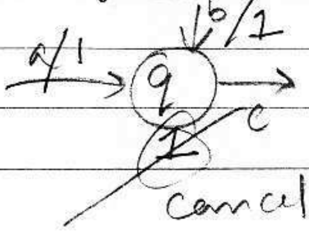
∴ The corresponding Mealey machine, M'.

$M' = (Q, \Sigma, \Delta, \delta, \lambda', q_0)$

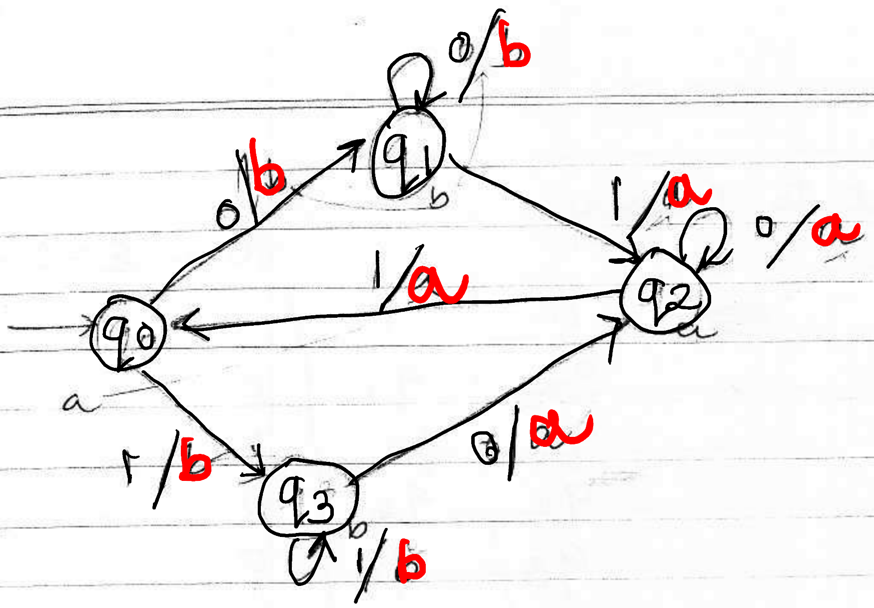
only this o/p funct^n changes rest all are same

$\lambda' : Q \times \Sigma \rightarrow \Delta$

$\lambda'(q, a) = \lambda(\delta(q, a))$



cancel & associate this o/p with incoming transitions.



→ Now Table to table conversion.

Moore

$q \backslash \Sigma$	0	1	λ
$\rightarrow q_0$	q_1	q_3	a
q_1	q_1	q_2	b
q_2	q_2	q_0	a
q_3	q_2	q_3	b

plainly copy it

	0		1	
	NS	o/p	NS	o/p
$\rightarrow q_0$	q_1	q1 ka o/p b	q_3	b
q_1	q_1	b	q_2	a
q_2	q_2	a	q_0	a
q_3	q_2	a	q_3	b

write o/p symbols g the Next state

Q. Convert to Mealy

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

PS	~~NS~~ 0	1	λ
$\rightarrow q_0$	q_3	q_1	0
q_1	q_1	q_2	1
q_2	q_2	q_3	0
q_3	q_3	q_0	0

Q	0		1	
	~~NS~~ NS	O/P	NS	O/P
$\rightarrow q_0$	q_3	0	q_1	1
q_1	q_1	1	q_2	0
q_2	q_2	0	q_3	0
q_3	q_3	0	q_0	0

classmate
Date
Page

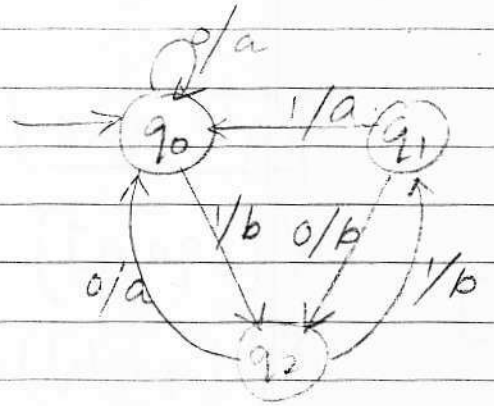
Conversion of Mealey machine to Moore machine.

1. If the output symbols ~~with~~ associated with the incoming transistions to a state are same, then assign that output symbol to that state.

2. If the output symbols with the incoming transistions to a state are not same then split that state as many times as the output symbols, with each state producing a different o/p symbol.

3. If there are ~~no~~ zero/no incoming transitions to a state then assign any output symbol to that state.

Q.



Moore $M(Q, \Sigma, \Delta, \delta, \lambda, q_0)$.

$\Downarrow$

Mealey $M'(Q, \Sigma, \Delta, \delta, \lambda', q_0)$.

But for Mealey to Moore
$Q \rightarrow Q'$ (States are going to change as
where $Q' = Q \times \Delta$ there will be additional states).
Σ will remain same.
Δ will remain same because the o/p has to remain same for a given i/p string

Mealy $M = (Q, \Sigma, \Delta, \delta, \lambda, q_0)$

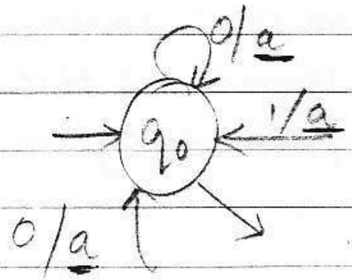
Moore $M' = (Q', \Sigma, \Delta, \delta', \lambda', q_0')$.

$\lambda'([q, x]) = x$

$\boxed{q_0' = [q_0, b]}$ → General.

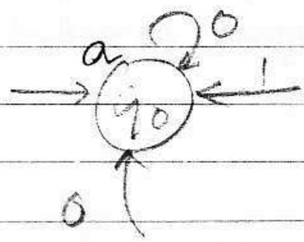
one of the o/p symbol.

Focus on all incoming transitions.



For all incoming transitions o/p alphabet is same.

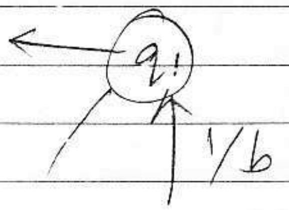
So this alphabet is associated with the state.



$\therefore q_0' = [q_0, a]$

$\boxed{\therefore Q' = Q \times \Delta}$

Next state q_1

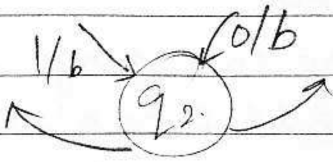


$\therefore [q_1, b]$

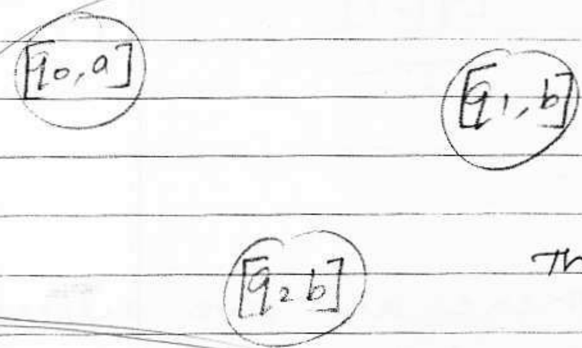
$\lambda'([q_0, a]) = a$

$\lambda'([q_1, b]) = b$

$\lambda'([q_2, b]) = b$

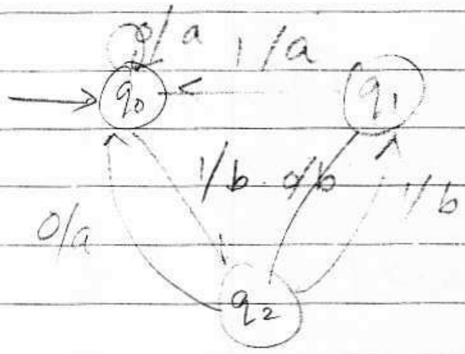


$\therefore [q_2, b]$

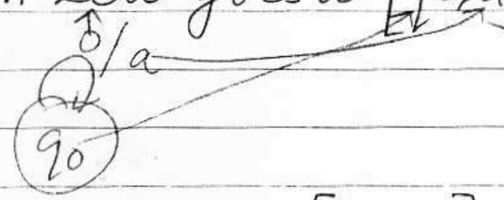


These are the states.

Now read :



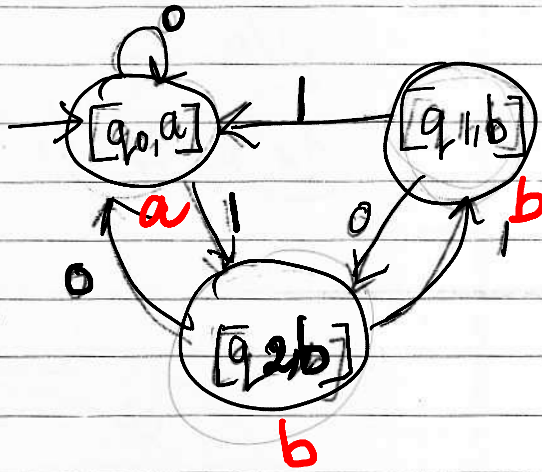
q_0 on zero goes to $[q_0,a]$



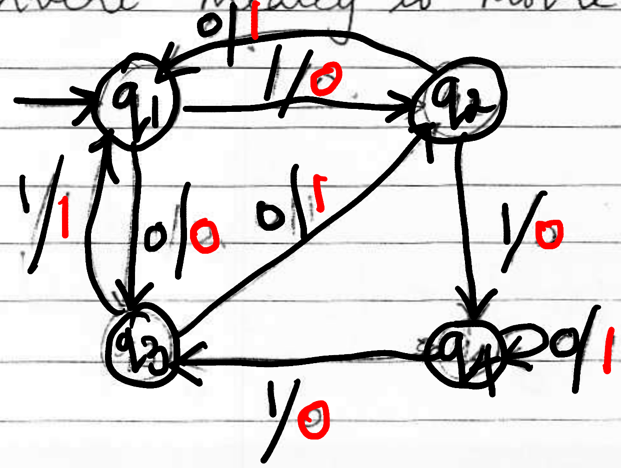
q_0 on 1 goes to $[q_2,b]$

q_1 on 0 goes to $[q_2,b]$
q_1 on 1 goes to $[q_0,a]$

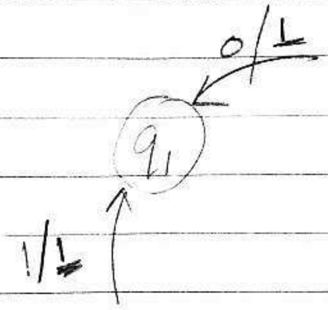
q_2 on 0 goes to $[q_0,a]$
q_2 on 1 goes to $[q_1,b]$.



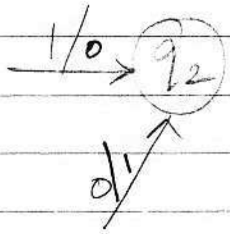
Q Convert Mealey to Moore



Sol:

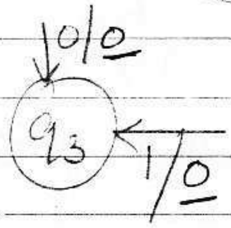


∴ $[q_1, 1]$

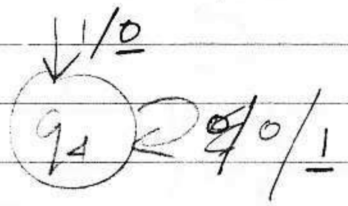


There are two different output symbols.
So split q_2 into two different states.

$[q_2, 0]$ $[q_2, 1]$



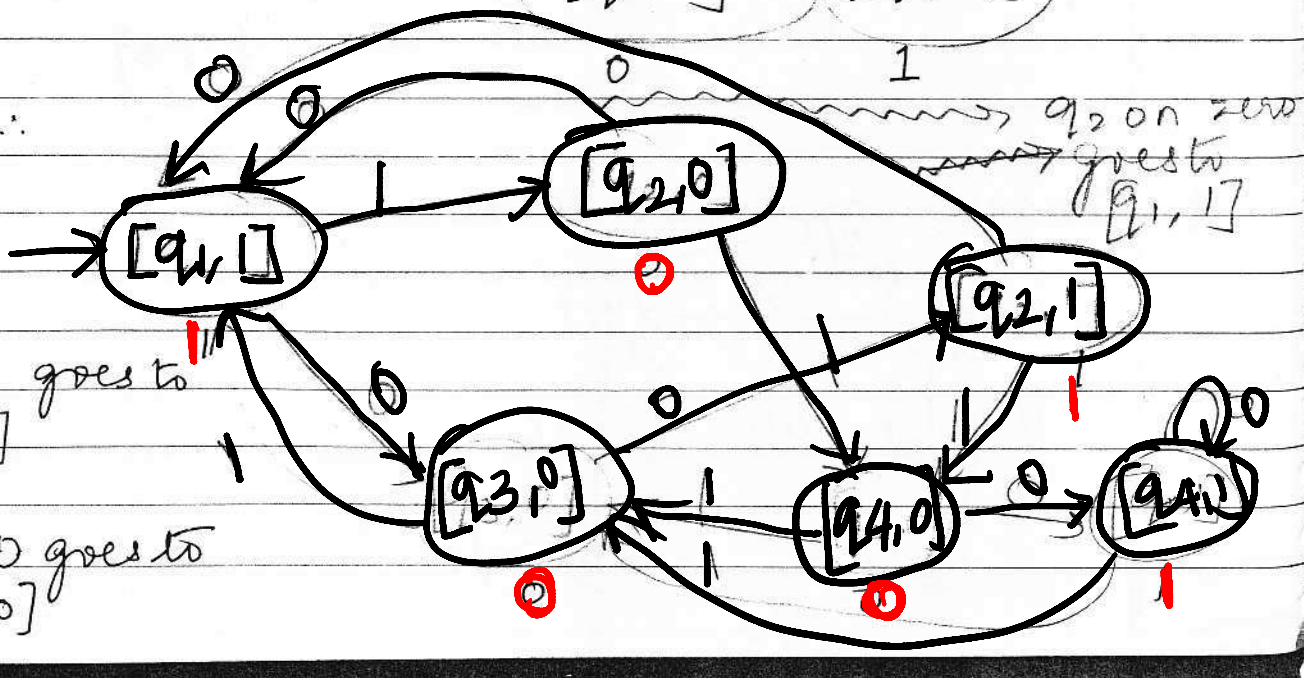
∴ $[q_3, 0]$



∴ Two diff o/p symbols.
So split.

$[q_4, 0]$, $[q_4, 1]$

∴



q_1 on 1 goes to $[q_2, 0]$

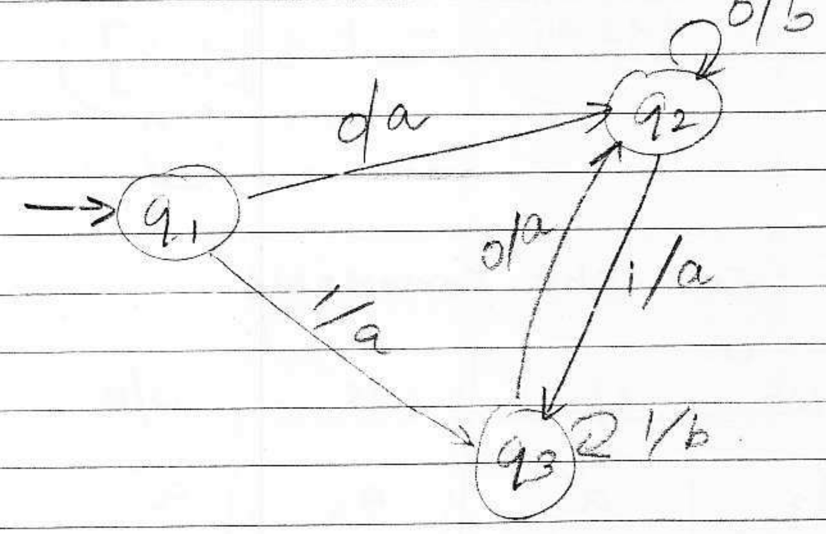
q_1 on 0 goes to $[q_3, 0]$

q_4 on 0 goes to $[q_4, 1]$ (And the zero transition will be from both $[q_4, 0]$, $[q_4, 1]$.

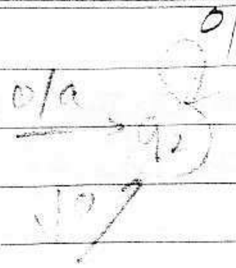
for the states which have been split, we have to show the transition from ~~both~~ all the ~~splitted~~ split states.

Q Convert given Mealey machine to Moore machine.

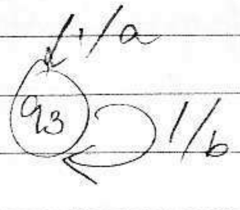
PS	NS (0)	o/p	NS (1)	o/p
q_1	q_2	a	q_3	a
q_2	q_2	b	q_3	a
q_3	q_2	a	q_3	b



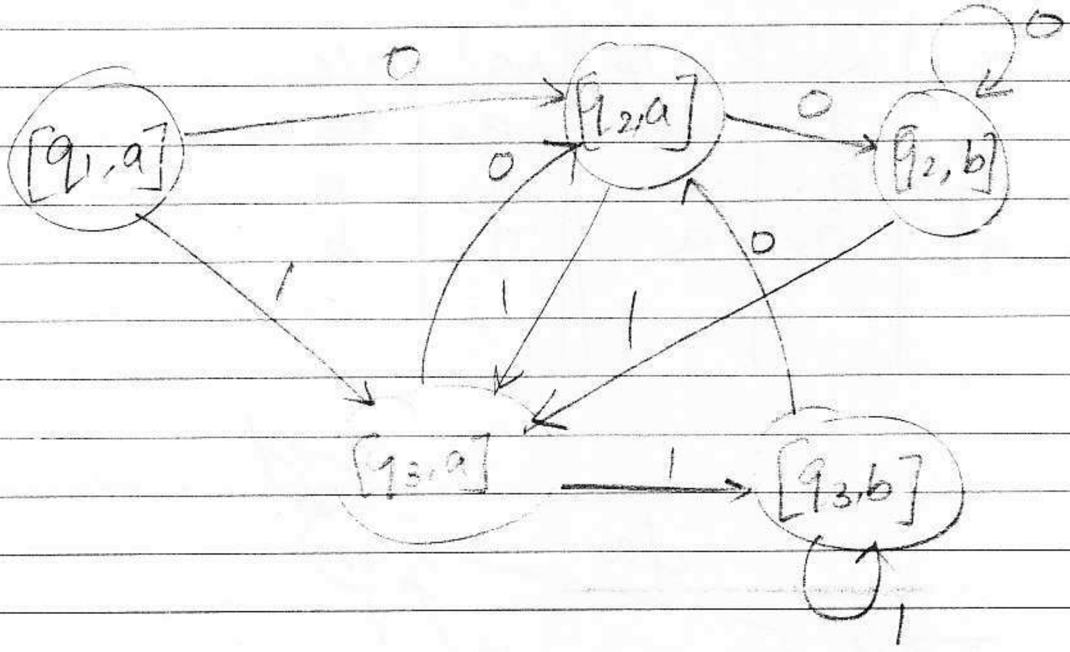
q_1: no incoming, so assume any output symbol.
let us assume 'a'
$\therefore [q_1, a]$



: split : $[q_2, a]$ $[q_2, b]$



split: $[q_3, a]$ $[q_3, b]$



Now table - to - table conversion

q_1 0 q_2 a

PS	0: NS	0: o/p	1: NS	1: o/p
q_1	q_2	a	q_3	a
q_2	q_2	b	q_3	a
q_3.	q_2	a.	q_3	b

Similarly we have to split q_3

q_2 a q_2 b

So we decide ~~we~~ have to split q_2

Now q_1 does not occur in any NS column
So ~~q_1~~ for q_1 we assume any o/p symbol.
Let it be 'a'.

PS	Σ 0	1	o/p
$[q_1, a]$	$[q_2, a]$	$[q_3, a]$	a
$[q_2, a]$	$[q_2, b]$	$[q_3, a]$	a
$[q_2, b]$	$[q_2, b]$	$[q_3, a]$	b
$[q_3, a]$	$[q_2, a]$	$[q_3, b]$	a
$[q_3, b]$	$[q_2, a]$	$[q_3, b]$	b

Write all states and their ~~first~~ associated symbols first.
Now.

classmate Date Page

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

HW

Q.

	0		1	
PS	NS	OP	NS	OP
$\rightarrow q_1$	q_1	1	q_2	0
q_2	q_4	1	q_4	1
q_3	q_2	1	q_3	1
q_4	q_3	0	q_1	1

8