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moore & mealey machine

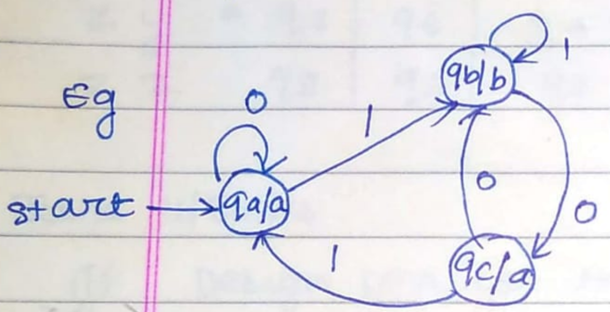
moore machine

Defination - [It is a finite automata with no final state & it produces O/P sequence for the given I/P sequence. In moore m/c, the O/P symbol is associated with each state.]

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

where Q = finite set of states
Σ = I/P alphabet
Δ = O/P alphabet
δ = transition f^n $\delta : Q \times \Sigma \to Q$
λ = O/P mapping $\lambda : Q \to \Delta$
q_0 = start state $q_0 \in Q$

Eg



$Q = \{q_A, q_B, q_C\}$
$\Delta = \{a, b\}$
$\Sigma = \{0, 1\}$ $q_0 = q_A$
$\lambda =$
$\lambda(q_A) = a$
$\lambda(q_B) = b$
$\lambda(q_C) = a$

$\Sigma = (0,1)$
$\Delta = (a,b)$
$Q = (q_a, q_b, \ldots)$

Q \ Σ	0	1
→ q_A	q_A	q_B
q_B	q_C	q_B
q_C	q_B	q_A

working

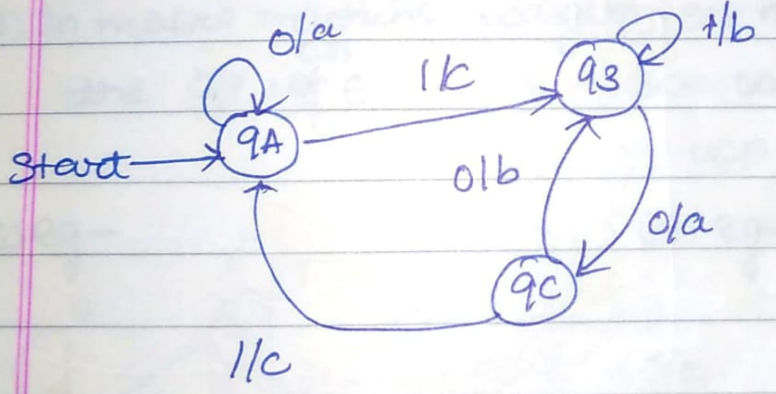
$(q_A, 1010)$ abaaa
$\vdash (q_B, 010)$
$\vdash (q_C, 10)$
$\vdash (q_A, 0)$
$\vdash (q_A, \epsilon)$

* melay machine

✓ Defination [It is a FA with no final state & it produces the O/P sequence for the given I/P sequence.
In mealy m/c, the O/P symbol is associated with transition]

$\boxed{M = (Q, \Sigma, \Delta, \delta, \lambda, q_0)}$ $\quad M = (Q, \Sigma, \Delta, \delta, \lambda, q)$

where
- Q = finite set of states
- Σ = I/P alphabet
- Δ = O/P alphabet
- δ = transition function $\delta : Q \times \Sigma \to Q$
- λ = O/P mapping $\lambda : Q \times \Sigma \to \Delta$
- q_0 = Start state $q_0 \in Q$



$Q = \{q_A, q_B, q_C\}$
$\Delta = \{a, b, c\}$
$\Sigma = \{0, 1\}$
$q_0 = q_A$

Q \ Σ	0	1
→ qA	qA	qB
qB	qC	qB
qC	qB	qA

Q \ Σ	0	1
→ qA	a	c
qB	a	b
qC	b	c

working

$(q_A, 1011)$ cacc

$\vdash (q_B\ 011)$

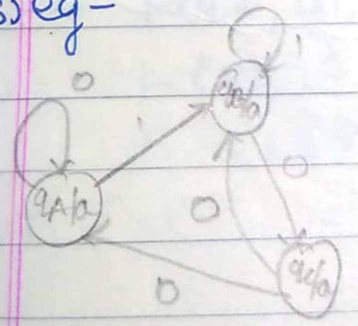
$\vdash (q_C, 11)$

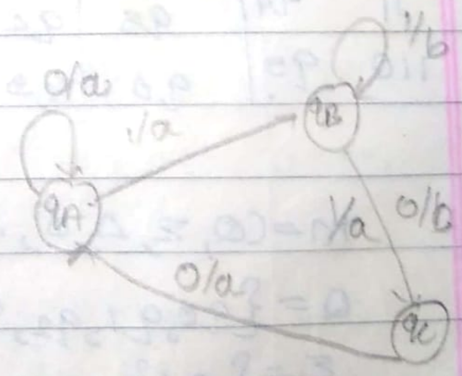
$\vdash (q_A, 1)$

$\vdash (q_B, \epsilon)$

Design moore m|c to o|p

moore machine	mealey machine
(1) In moore machine the output symbol is associated with each state	(1) In mealey m/c is associated with each transition
(2) In moore machine output is dependent on the state	(2) In mealey machine the O/P is dependant on state & the input
(3) In moore machine the output mapping is defined as $\lambda :- Q \rightarrow \Delta$	(3) In mealey machine O/P mapping is defined as $\lambda :- Q \times \Sigma \rightarrow \Delta$
(4) In moore machine if the length of the I/P sequence is 'n' then the length of the O/P sequence is n+1	(4) In mealey machine if length of the I/P sequence is 'n' then the length of the O/P sequence is n
(5) In moore machine we can get the O/P on ϵ	(5) In mealey machine we cannot get the O/P on ϵ
(6) eg-	(6) eg-





✓ minimization of moore machine
states can be merged if they have the same transitions & o/p symbols along with the states are also same.

✓ Design moore m/c to o/p
'A' if i/p ends in '101'
'B' if i/p ends in '110'
'C' otherwise over $\Sigma = \{0, 1\}$

Type I point

S1 Theory (def of moore m/c)

S2

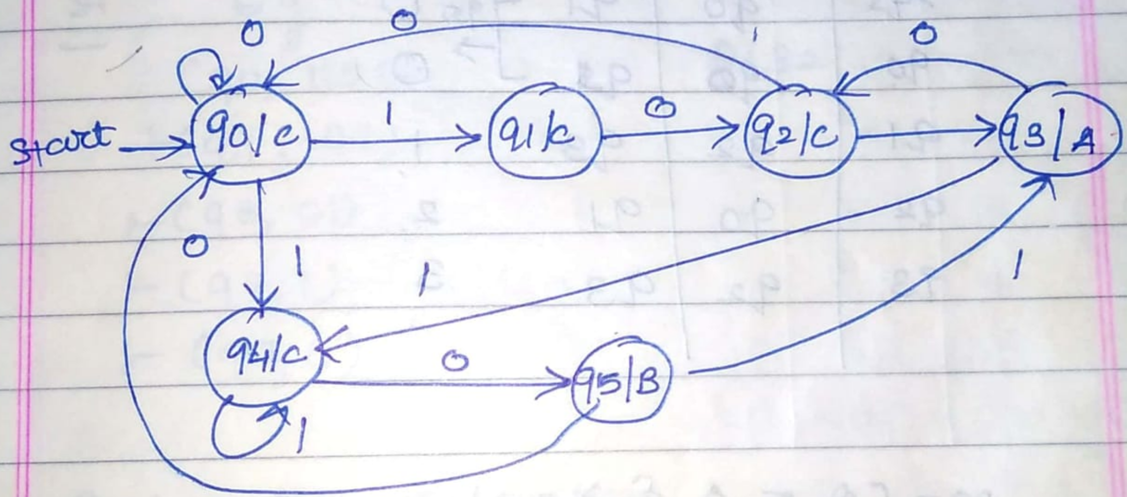
	S \ I	0	1	
	$\rightarrow q_s$	q_0	q_1	
0	q_0	q_0	q_1	
1	q_1	q_2	q_4	C
10	q_2	q_0	q_3	C
101	q_3	q_2	q_4	A
11	q_4	q_5	q_4	C
110	q_5	q_0	q_3	B

$q_s, q_0 \;]\; \xrightarrow[C]{C} q_0$

S3
$m = (Q, \Sigma, \Delta, \delta, \lambda, q_0)$
$Q = \{q_0, q_1, q_2, q_3, q_4, q_5\}$
$\Sigma = \{0, 1\}$
$\Delta = \{A, B, C\}$
$q_0 = q_0$

Scanned by CamScanner

δ \ Σ	0	1	
→ q_0	q_0	q_1	$\lambda(q_0) = C$
q_1	q_2	q_4	$\lambda(q_1) = C$
q_2	q_0	q_3	$\lambda(q_2) = C$
q_3	q_2	q_4	$\lambda(q_3) = A$
q_4	q_5	q_4	$\lambda(q_4) = C$
q_5	q_0	q_3	$\lambda(q_5) = B$



S4

$(q_0, 1101)$ CCCBA

$\vdash (q_1, 101)$

$\vdash (q_4, 01)$

$\vdash (q_5, 1)$

$\vdash (q_3, \epsilon)$

Design moore m/c for the following process - "print residue module 4 for binary number"

S1

S2

S \ I	0 $(2R+0)\%4$	1 $(2R+1)\%4$	
$\rightarrow q_s$	q_0	q_1	
q_0	q_0	q_1	0
q_1	q_2	q_3	1
q_2	q_0	q_1	2
q_3	q_2	q_3	3

$q_s, q_0 \rightarrow q_0$ 0

S3

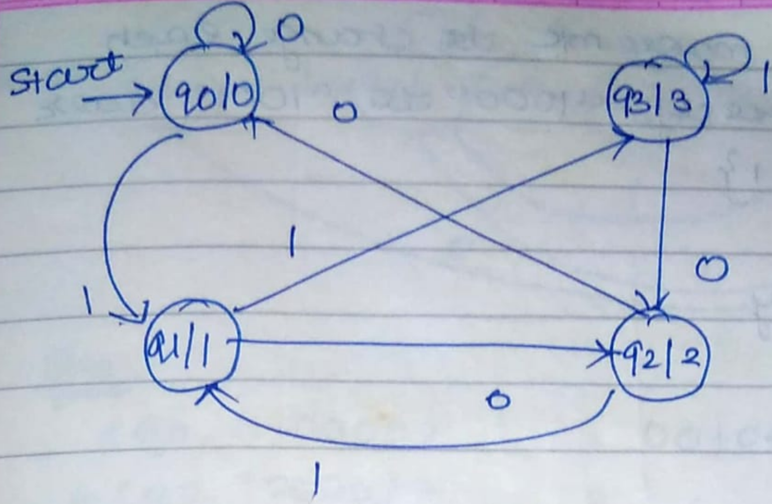
$M = (Q, \Sigma, \Delta, \delta, \lambda, q_0)$

$Q = \{q_0, q_1, q_2, q_3\}$

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

$\Delta = \{0, 1, 2, 3\}$

Q \ Σ	0	1	
$\rightarrow q_0$	q_0	q_1	$\lambda(q_0) = 0$
q_1	q_2	q_3	$\lambda(q_1) = 1$
q_2	q_0	q_1	$\lambda(q_2) = 2$
q_3	q_2	q_3	$\lambda(q_3) = 3$



SA   Eg

$(q_0, 1101)$ 01321

$\vdash (q_1, 101)$

$\vdash (q_3, 01)$

$\vdash (q_2, 1)$

$\vdash (q_2, \epsilon)$

✓ Points to remember

(1) The logic of searching = logic of ends in without any final state

(2) In moore & mealey m/c intermediate bits cannot be changed.

Type II change o/p

✓ Design moore m/c to change each occurence of "1000" to "1001" over $\Sigma = \{0, 1\}$

Step1 Theory

Step2 Logic

	S \ I	0	1	o/p
	$\rightarrow q_s$	q_0	q_1	0
0	q_0	q_0	q_1	0
1	q_1	q_2	q_1	1
10	q_2	q_3	q_1	0
100	q_3	q_4	q_1	0
1000	q_4	q_0	q_1	1

$\rightarrow q_0$

Step3 $m = (Q, \Sigma, \Delta, S, \lambda, q_0)$

$Q = \{q_0, q_1, q_2, q_3, q_4\}$

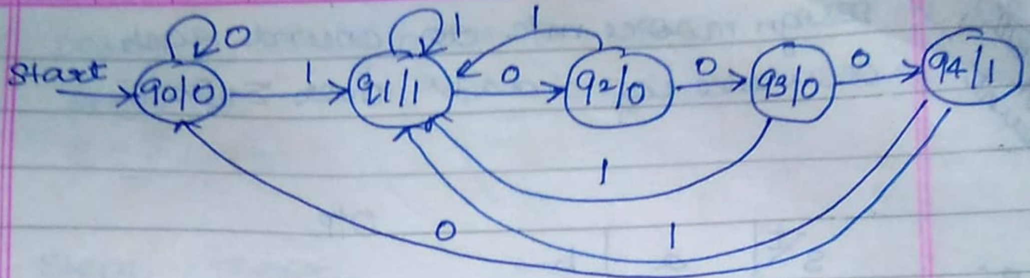
$\Sigma = \{0, 1\}$

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

$q_0 = q_0$

δ

Q \ Σ	0	1	
$\rightarrow q_0$	q_0	q_1	$\lambda(q_0) = 0$
q_1	q_2	q_1	$\lambda(q_1) = 1$
q_2	q_3	q_1	$\lambda(q_2) = 0$
q_3	q_4	q_1	$\lambda(q_3) = 0$
q_4	q_0	q_1	$\lambda(q_4) = 1$



Step

$(q_0, 010000)$ 0010010

$\vdash (q_0, 10000)$

$\vdash (q_1, 0000)$

$\vdash (q_2, 000)$

$\vdash (q_3, 00)$

$\vdash (q_4, 0)$

$\vdash (q_0, \epsilon)$

✓ Design moore m/c to change each occurrence of "120" to "122" over $\Sigma = \{0, 1, 2\}$

Logic.

	S \ I	0	1	2		O/P
	$\rightarrow q_s$	q_0	q_1	q_2	$\rightarrow q_0$	0
0	q_0	q_0	q_1	q_2		0
1	q_1	q_0	q_1	q_3		1
2	q_2	q_0	q_1	q_2		2
12	q_3	q_4	q_1	q_2		2
120	q_4	q_0	q_1	q_2		2

type III count

Design moore m/c to count each occurence of "aab" over $\Sigma=\{a,b\}$

	S \ I	a	b	O/P
$\rightarrow q_s$	q_s	q_0	q_1	ϵ
q_0	a	q_2	q_1	ϵ
q_1	b	q_0	q_1	ϵ
q_2	aa	q_2	q_3	ϵ
q_3	aab	q_0	q_1	0

$\rightarrow q_1$

unary

0	ϵ
1	0
2	00
3	000
4	0000

Minimization of mealey machine

① States can be merged if

a) all states have same transitions &

b) output symbols along with the transitions are also same.

✓ Design mealey machine to O/P 'A' if I/P ends in "101" 'R' otherwise over $\Sigma = \{1 0\}$

Type I print

Step1 Theory
(defination of mealey m/c)

Step2 Logic

	S \ I	0	1	
	→ qs	q0	q1	q0
0	q0	q0	q1	
1	q1	q2	q1	q1
10	q2	q0	q3	
101	q3	q2	q1	

S \ I	0	1
→ qs	R	R
q0	R	R
q1	R	R
q2	R	A
q3	R	R

Step3

$m = (Q, \Sigma, \Delta, \delta, \lambda, q0)$

$Q = \{q0, q1, q2\}$

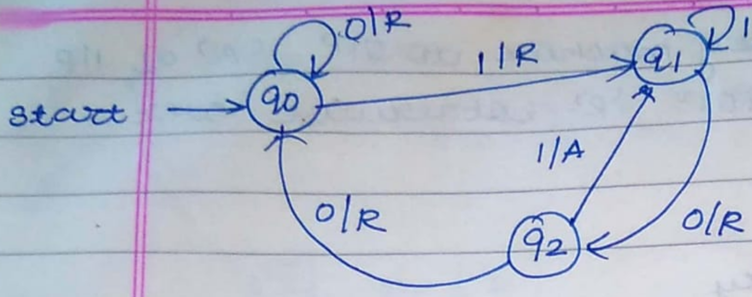
$\Sigma = \{0, 1\}$

$\Delta = \{A, R\}$

$q0 = q0$

δ Q \ Σ	0	1
→ q0	q0	q1
q1	q2	q1
q2	q0	q1

Q \ Σ	0	1
→ q0	R	R
q1	R	R
q2	R	A



Step4

$(q_0, 1101)$ RRRA

$\vdash (q_1, 101)$

$\vdash (q_1, 01)$

$\vdash (q_2, 1)$

$\vdash (q_1, \epsilon)$

✓ Design mealey m/c to o/p even & odd depending on the number of 1's encountered are even & odd over $\Sigma = \{0, 1\}$

Step1 Theory

Step2 Logic

	S \ I	0	1	
n1(x)	→qs	q0	q1	q0
even	q0	q0	q1	
odd	q1	q1	q0	

S \ I	0	1
→qs	even	odd
q0	even	odd
q1	odd	even

Step3 Implementation

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

$Q = \{q_0, q_1\}$

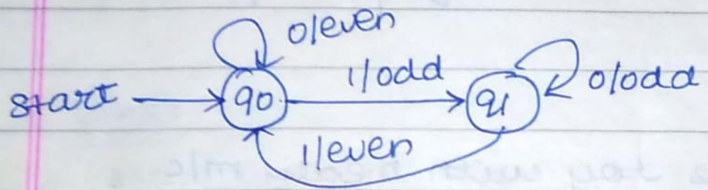
$\Sigma = \{0, 1\}$

$\Delta = \{\text{Even}, \text{odd}\}$

$q_0 = q_0$

Q \ Σ	0	1
→ q0	q0	q1
q1	q1	q0

Q \ Σ	0	1
→ q0	Even	odd
q1	odd	Even



Step4 $(q_0, 1101)$ Odd even even odd

$\vdash q_1 (101)$

$\vdash (q_0 (01)$

$\vdash (q_0, 1)$

$\vdash (q_1, \epsilon)$

✓ Design mealy m/c to change each occurrence of "abb" to "aba" over $\Sigma = \{a, b\}$

doubt? 2nd table

	S \ I	a	b	
	→ qs	q0	q1	
a	q0	q0	q2	a
b.	q1	q0	q1	b
ab	q2	q0	q3	b
abb	q3	q0	q1	a

S \ I	a	b
qs	a	b
q0	a	b
q1	a	b
q2	a	a
q3	a	b

→ q1

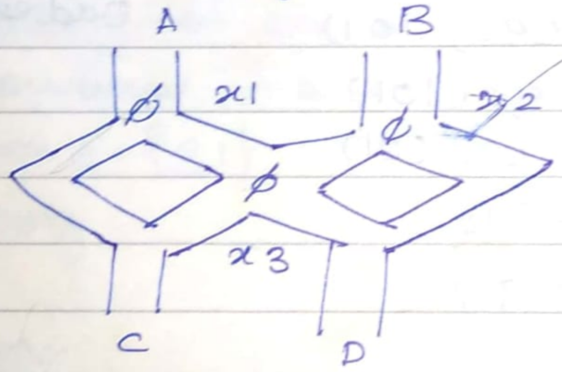
☆ Design mealey m/c for the following
$r = (0+1)^* (00+11)$

Solution logic

S \ I		0	1
	$\rightarrow q_s$	q_0	q_1
0	q_0	q_2	q_1
1	q_1	q_0	q_3
00	q_2	q_2	q_1
11	q_3	q_0	q_3

S \ I	0	1	
$\rightarrow q_s$	R	R	
q_0	A	R	
q_1	R	A	$\rightarrow q_0$
q_2	A	R	$\rightarrow q_1$
q_3	R	A	

model the toy with mealy m/c



ϕ - L
$\mathcal{Q}$ - R

x_1	x_2	x_3	
L	L	L	q_0
L	L	R	q_1
L	R	L	q_2
L	R	R	q_3
R	L	L	q_4
R	L	R	q_5
R	R	L	q_6
R	R	R	q_7

x_1	x_2	x_3	S	O
R	L	L	q_4	C
R	L	R	q_5	C
R	R	L	q_6	C
R	R	R	q_7	C
L	L	R	q_1	C
L	L	L	q_0	D
L	R	R	q_3	C
L	R	L	q_2	D

x_1	x_2	x_3	S	O
L	R	R	q_3	C
L	R	L	q_2	D
L	L	L	q_0	D
L	L	R	q_1	D
R	R	R	q_7	C
R	R	L	q_6	D
R	L	L	q_4	D
R	L	R	q_5	D

Step3

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

$Q = \{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}$

$\Sigma = \{A, B\}$

$\Delta = \{C, D\}$

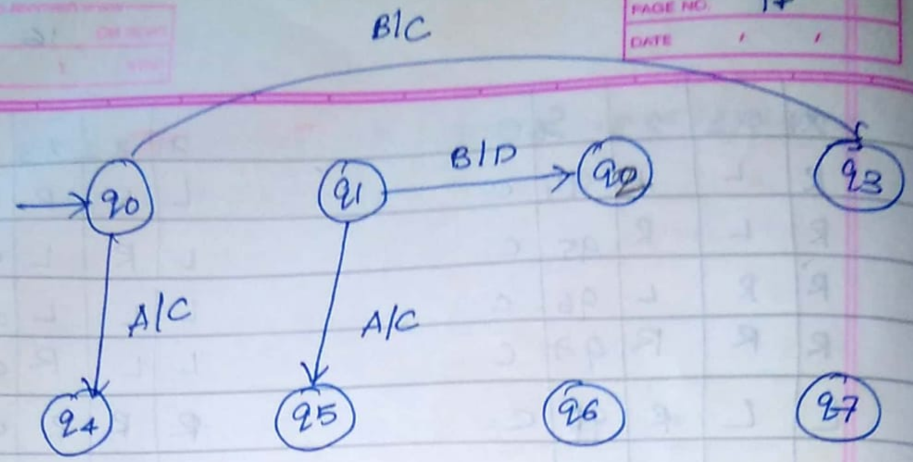
$q_0 = q_0$

$\delta =$

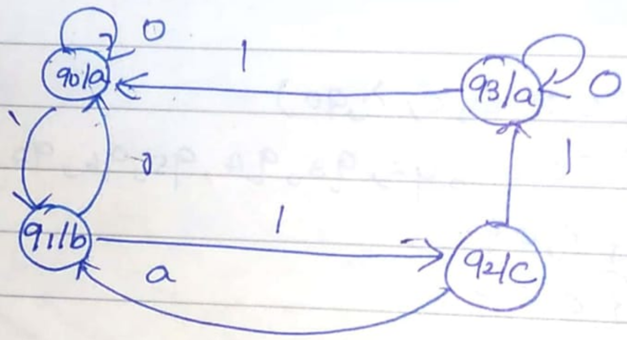
Q\Σ	A	B
→ q_0	q_4	q_3
q_1	q_5	q_2
q_2	q_6	q_0
q_3	q_7	q_1
q_4	q_3	q_7
q_5	q_0	q_6
q_6	q_3	q_4
q_7	q_2	q_5

$\lambda =$

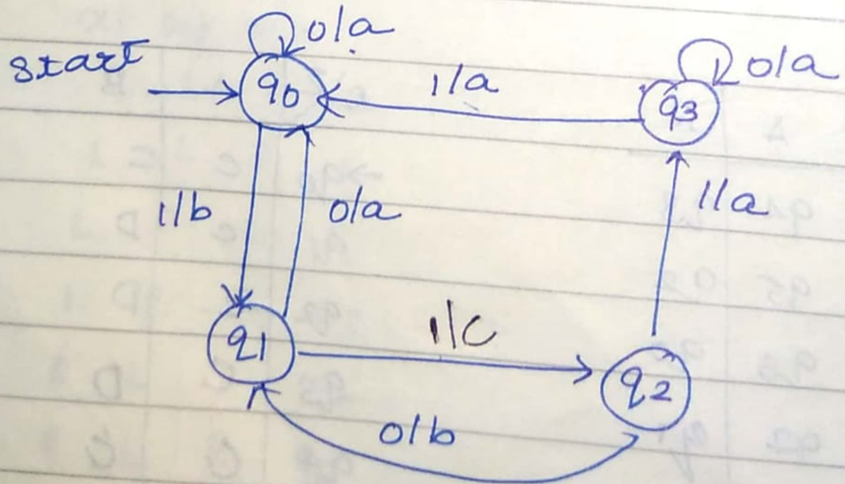
Q\Σ	A	B
→ q_0	C	C
q_1	C	D
q_2	C	D
q_3	C	D
q_4	C	C
q_5	D	D
q_6	C	D
q_7	D	D



moore m/c to mealey machine
assign the O/P symbol along with the state to all of its incoming transactions



Solution

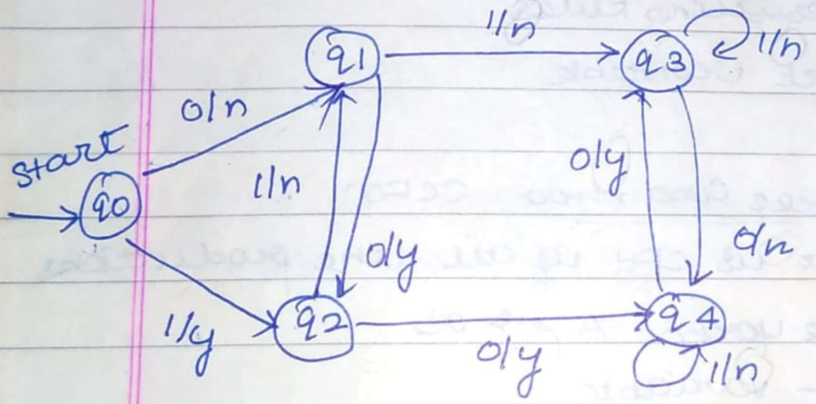


mealey m/c to moore m/c

If the O/P symbols along with incomming are same, then assign that symbol to that state

If the O/P symbols along with incomming are not same, then split that state as many times as O/P symbols with each state producing a different O/P

If there are no incomming transitions to a state then any O/P signal can be assigned to that state



mealey m/c