COMPUTER ENGINEERING DEPARTMENT

ASSIGNMENT NO-03

Sub: Theory of Computer Science

COURSE: T.E. Year: 2020-2021 Semester: V
DEPT: Computer Engineering
SUBJECT CODE: CSC504 DUE DATE: 21/11/2020

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Class: TE-Comps B Date of Submission: 20/11/2020

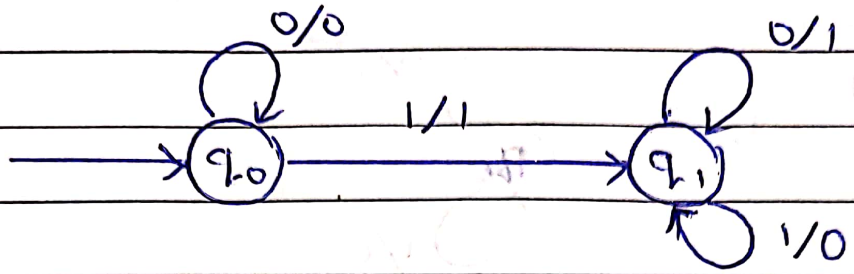
Tutorial 3

1. Design Mealy machine to find out 2's complement of a binary number.
2. Design Moore and Mealy machine to Decrement a binary number.
3. Design Moore machine for the language (0+1)*(00+11) and convert it to Mealy machine.
4. Design Moore and Mealy machine to change each occurrence of 100 to 101 over Σ= {0,1}.
5. Design Mealy m/c to o/p even & odd depending on the no. of 1's encounters in the i/p string over Σ = {0, 1} and minimize Mealy m/c.
6. Design Mealy m/c to find the addition of two binary numbers.
7. Design Moore machine to count each occurrence of 'aab' over Σ = {a,b}
8. Differentiate between Moore m/c and Mealy m/c.

Q.1. Design Mealy machine to find out 2's complement of a binary number.

Ans:

2's complement = 1's complement + 1



- The finite automation M_1

We can define M_1 formally by writing

$M_1 = (Q, \Sigma, \delta, \Delta, \lambda, q_0)$

1. $Q = \{q_0, q_1\}$
2. $\Sigma = \{0, 1\}$
3. $\Delta = \{0, 1\}$
4. $\delta : Q \times \Sigma \rightarrow Q$
5. $\lambda : Q \times \Sigma \rightarrow \Delta$

Present state	Next state			
	input = 0		input = 1	
	state	output	state	output
$\rightarrow q_0$	q_0	0	q_1	1
q_1	q_1	1	q_1	0

6. q_0 is the initial state.

Q1

Simulation (string : 10100)

Note : MSB $\leftarrow$ LSB

$\rightarrow \delta(q_0, 10100)$

$\rightarrow \delta(q_0, 1010) \rightarrow 0$

$\rightarrow \delta(q_0, 101) \rightarrow 0$

$\rightarrow \delta(q_1, 10) \rightarrow 1$

$\rightarrow \delta(q_1, 1) \rightarrow 1$

$\rightarrow \delta(q_1) \rightarrow 0$

$(10100)_{2\text{'s complement}}$

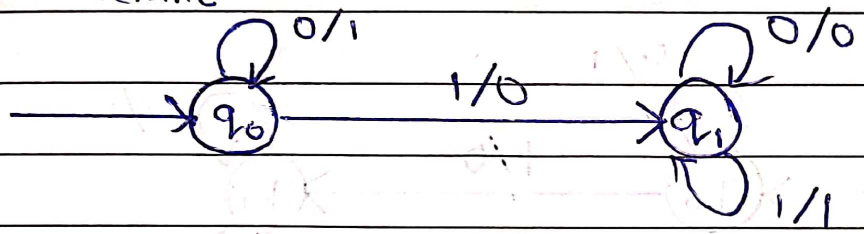
$\Rightarrow$ 01100

Q2. Design Moore and Mealy machine to decrement a binary number

Ans:

One can decrement a binary by adding 11...1 (all 1's is 2's complement of 1) to the given number. The addition should start from the least significant digit.

Mealy Machine



- The finite automation M_1

We can define M_1 formally by writing
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2. $\Sigma = \{0, 1\}$
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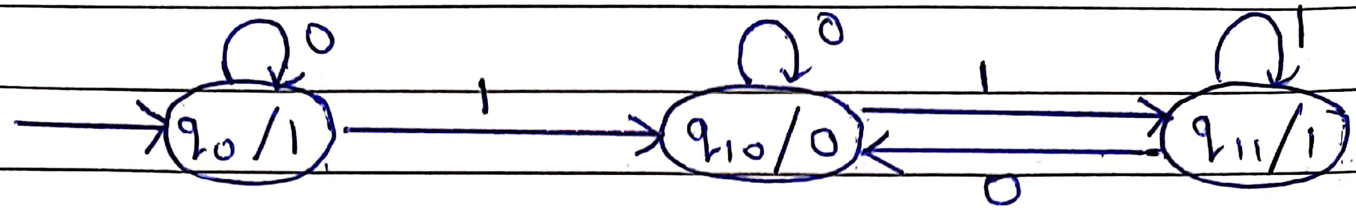
4. $\delta : Q \times \Sigma \longrightarrow Q$
5. $\lambda : Q \times \Sigma \longrightarrow \Delta$

Present state	Next state			
	input = 0		input = 1	
	state	output	state	output
$\rightarrow q_0$	q_0	1	q_1	0
q_1	q_1	0	q_1	1

6. q_0 is the initial state

Moore Machine



- The finite automation M_1

We can define M_1 formally by writing

$$M_1 = (Q, \Sigma, \delta, \lambda, \Delta, q_0)$$

1. $Q = \{q_0, q_{10}, q_{11}\}$
2. $\Sigma = \{0, 1\}$
3. $\Delta = \{0, 1\}$
4. $\delta : Q \times \Sigma \longrightarrow Q$
5. $\lambda : Q \longrightarrow \Delta$

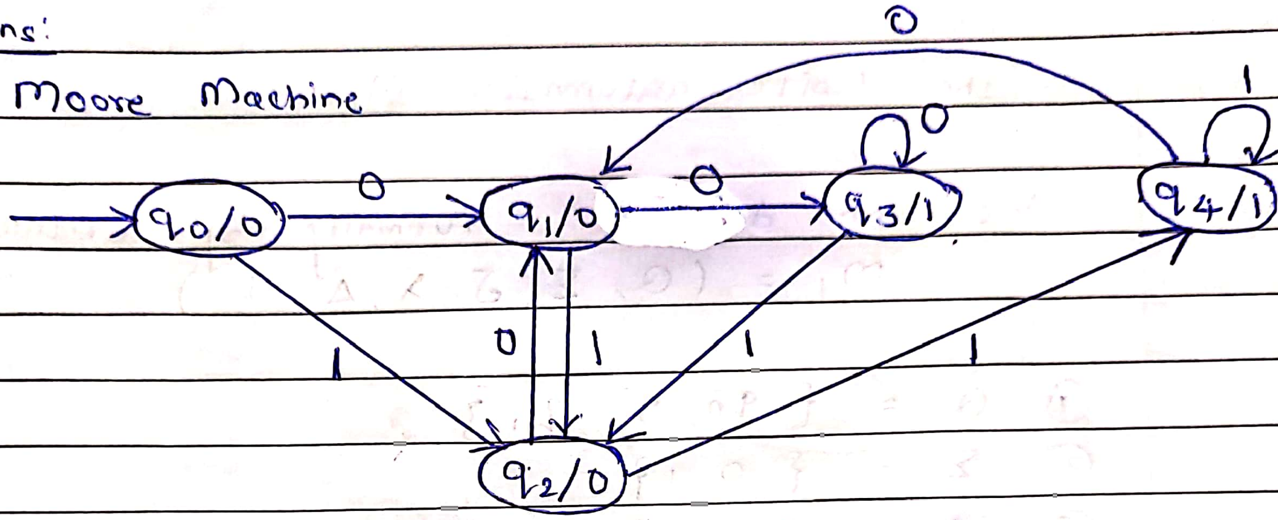
Present	Next state		
state	input = 0	input = 1	Output
$\rightarrow q_0$	q_0	q_{10}	1
q_{10}	q_{10}	q_{11}	0
q_{11}	q_{10}	q_{11}	1

6. q_0 is the initial state.

Q.3. Design Moore machine for the language $(0+1)^*(00+11)$ and convert it to Mealy machine.

Ans:

Moore Machine



- The finite automation M_1

We can define M_1 formally by writing
$M_1 = (Q, \Sigma, \delta, \Delta, \lambda, q_0)$

1. $Q = \{q_0, q_1, q_2, q_3, q_4\}$
2. $\Sigma = \{0, 1\}$
3. $\Delta = \{0, 1\}$
4. $\delta : Q \times \Sigma \rightarrow Q$
5. $\lambda : Q \rightarrow \Delta$

Present state	Next state input=0	Next state input=1	Output
$\rightarrow q_0$	q_1	q_2	0
q_1	q_3	q_2	0
q_2	q_1	q_4	0
q_3	q_3	q_2	1
q_4	q_1	q_4	1

6. q_0 is the initial state

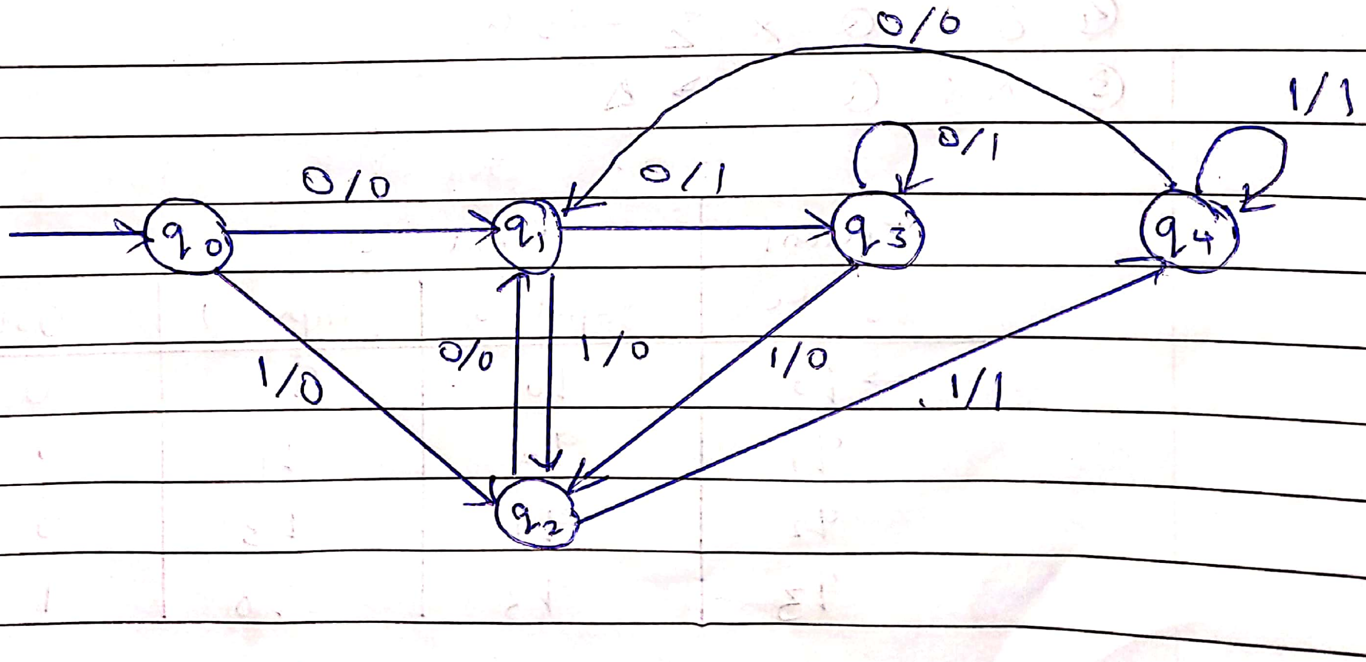
Mealy Machine

$M_1 = (Q, \Sigma, \delta, \Delta, \lambda, q_0)$

1. $Q = \{q_0, q_1, q_2, q_3, q_4\}$
2. $\Sigma = \{0, 1\}$
3. $\Delta = \{0, 1\}$
4. $\delta : Q \times \Sigma \longrightarrow Q$
5. $\lambda : Q \longrightarrow \Delta$

Present state	Next state			
	input = 0		input = 1	
	State	Output	State	Output
$\rightarrow q_0$	q_1	0	q_2	0
q_1	q_3	1	q_2	0
q_2	q_1	0	q_4	1
q_3	q_3	1	q_2	0
q_4	q_1	0	q_4	1

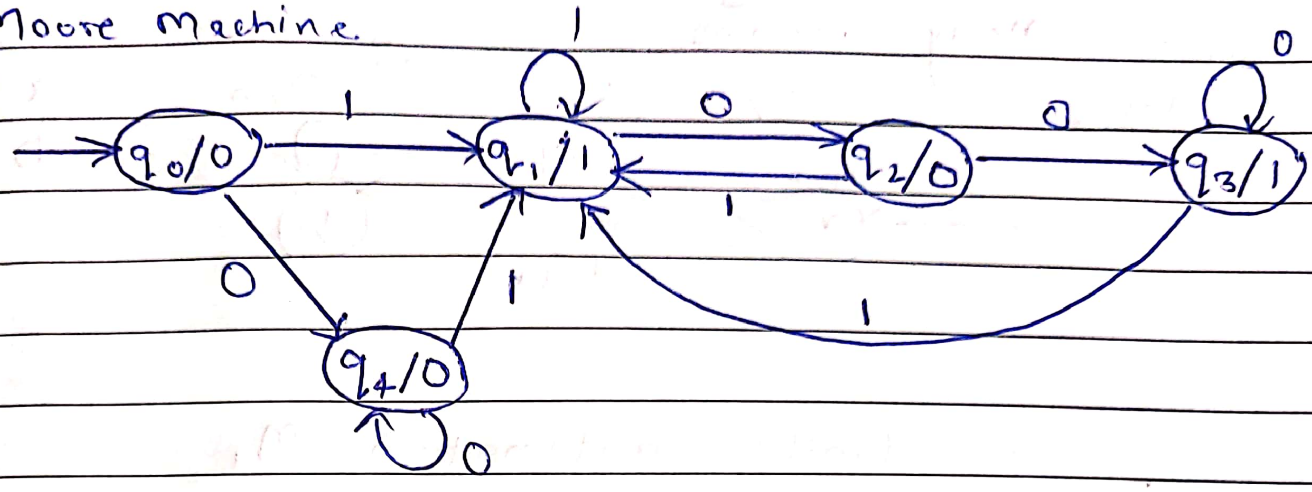
6. q_0 is the initial state



Q.4. Design Moore and Mealy machine to change each occurrence of 100 to 101 over $\Sigma = \{0, 1\}$

Ans:

Moore Machine



- The finite automation M_1

We can define M_1 formally by writing

$M_1 = (Q, \Sigma, \delta, \lambda, \Delta, q_0)$

1. q_0 is the initial state
2. $Q = \{q_0, q_1, q_2, q_3, q_4\}$
3. $\Sigma = \{0, 1\}$
4. $\Delta = \{0, 1\}$
5. $\delta : Q \times \Sigma \rightarrow Q$
6. $\lambda : Q \longrightarrow \Delta$

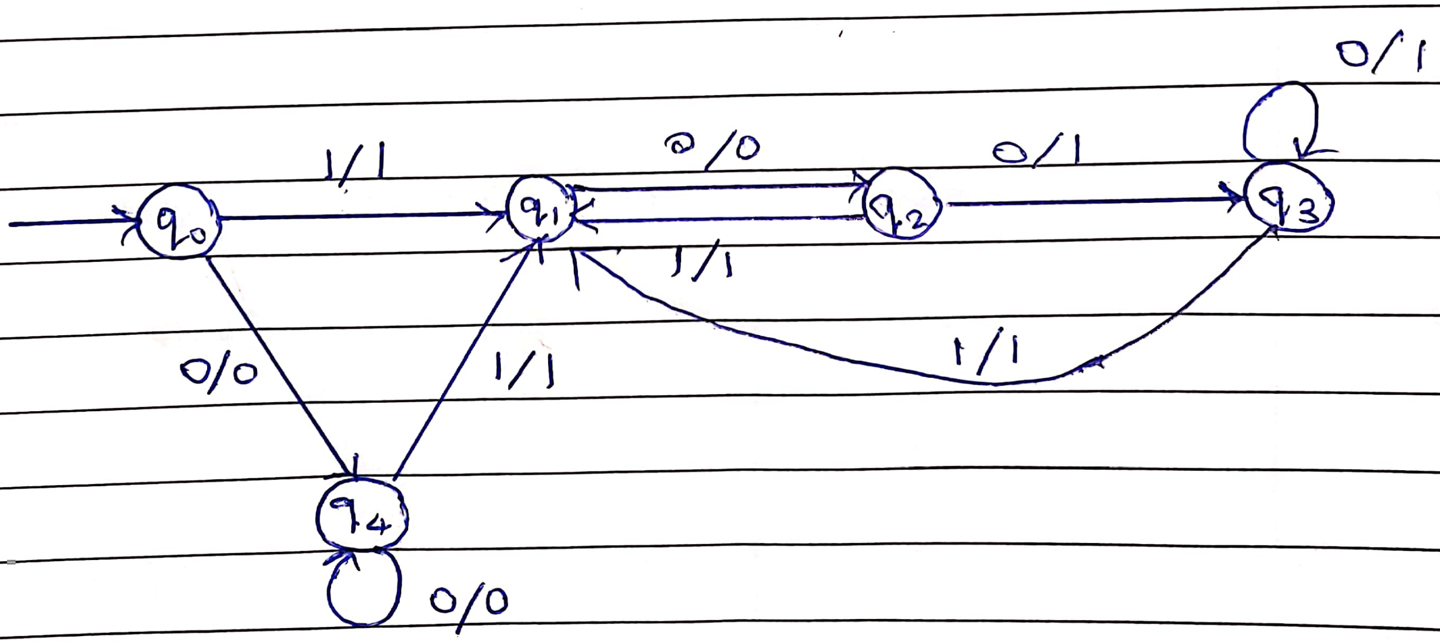
Present state	Next state input = 0	Next state input = 1	Output
$\rightarrow q_0$	q_4	q_1	0
q_1	q_2	q_1	1
q_2	q_3	q_1	0
q_3	q_3	q_1	1
q_4	q_4	q_1	0

Mealy Machine

$M_1 = (Q, \Sigma, \delta, \Delta, \lambda, q_0)$

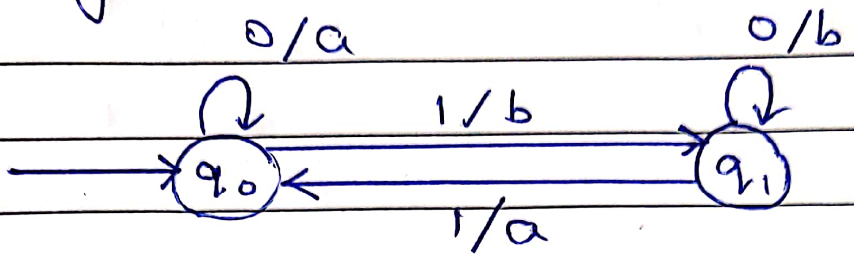
1. q_0 is the initial state
2. $Q = \{q_0, q_1, q_2, q_3, q_4\}$
3. $\Sigma = \{0, 1\}$
4. $\Delta = \{0, 1\}$
5. $\delta : Q \times \Sigma \rightarrow Q$
6. $\lambda : Q \times \Sigma \rightarrow \Delta$

Present State	Next State			
	input = 0		input = 1	
	State	Output	State	Output
$\rightarrow q_0$	q_4	0	q_1	1
q_1	q_2	0	q_1	1
q_2	q_3	1	q_1	1
q_3	q_3	1	q_1	1
q_4	q_4	0	q_4	1



Q.5. Design Mealy machine to output even and odd depending on the no. of 1's encountered in the input string over $\Sigma = \{0,1\}$ and minimize Mealy machine.

Ans:



a = Even
b = Odd

- The finite automation M_1

We can define M_1 formally by writing

$M_1 = (Q, \Sigma, \delta, \Delta, \lambda, q_0)$

1. $Q = \{q_0, q_1\}$
2. $\Sigma = \{0, 1\}$
3. $\Delta = \{a, b\}$
4. $\delta : Q \times \Sigma \rightarrow Q$
5. $\lambda : Q \times \Sigma \rightarrow \Delta$

Present state	Next state			
	input = 0		input = 1	
	state	Output	State	Output
$\rightarrow q_0$	q_0	a	q_1	b
q_1	q_1	b	q_0	a

6. q_0 is the initial state.

Minimization of given mealy machine

	0	1
$\rightarrow q_0$	q_0	q_1
q_1	q_1	q_0

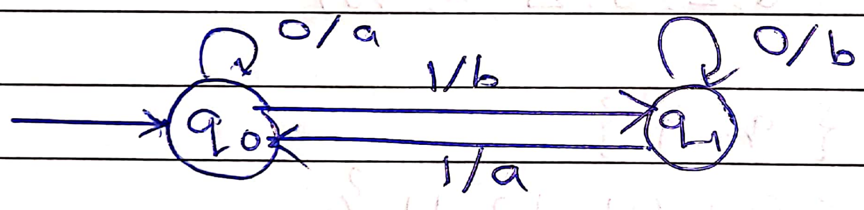
0 Equivalence $\{q_0\}$ $\{q_1\}$

1 Equivalence $\{q_0\}$ $\{q_1\}$

$\therefore$ Given mealy machine is already in minimal state

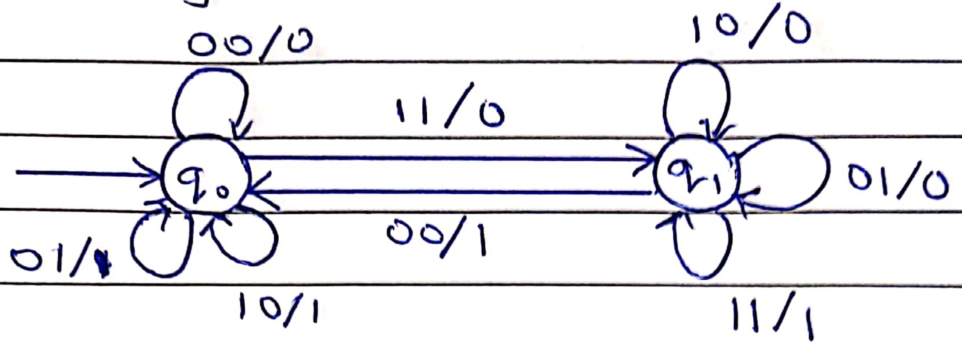
a = Even

b = Odd



Q.6. Design Mealy machine to find the addition of two binary numbers.

Ans:



- The finite automation M_1

We can define M_1 formally by writing

$M_1 = (Q, \Sigma, \delta, \Delta, \lambda, q_0)$

1. $Q = \{q_0, q_1\}$
2. $\Sigma = \{00, 01, 10, 11\}$
3. $\Delta = \{0, 1\}$
4. $\delta : Q \times \Sigma \rightarrow Q$
5. $\lambda : Q \times \Sigma \rightarrow \Delta$

Present state	Next state							
	input = 00		input = 01		input = 10		input = 11	
	state	Output	state	Output	state	Output	state	Output
$\rightarrow q_0$	q_0	0	q_0	1	q_0	1	q_1	0
q_1	q_0	1	q_1	0	q_1	0	q_1	1

6. q_0 is the initial state

Q.6 Simulation [Add $(6)_{10}$ & $(3)_{10}$]

$\rightarrow (q_0, 110, 011)$

$\rightarrow (q_0, 10, 11) \rightarrow 1$

$\rightarrow (q_1, 0, 1) \rightarrow 0 \; c$

$\rightarrow (q_1, \epsilon, \epsilon) \rightarrow 0 \; c$

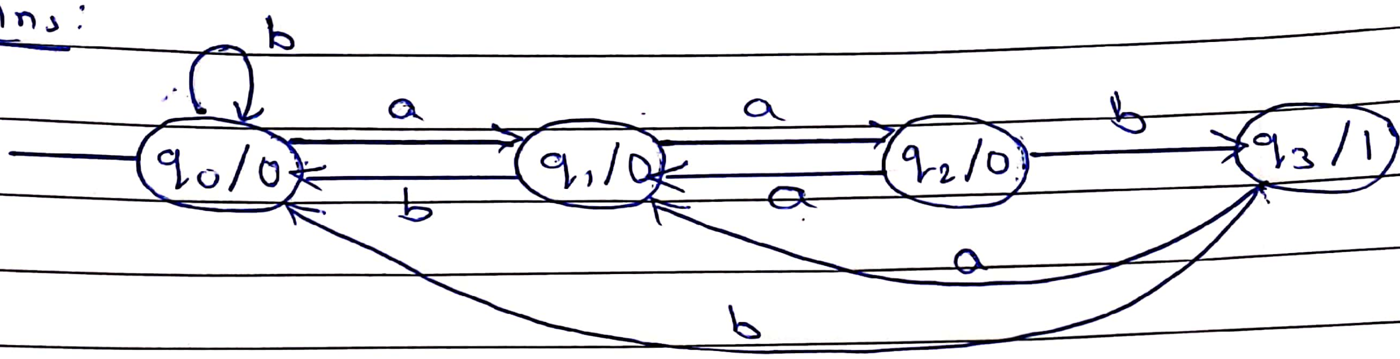
1

(1001)

$\Rightarrow (1001) = (9)_{10}$

Q.7. Design Moore machine to count each occurrence of 'aab' over $\Sigma = \{a, b\}$

Ans:



– The finite automation M_1

We can define M_1 formally by writing

$$M_1 = (Q, \Sigma, \delta, \lambda, \Delta, q_0)$$

1. $Q = \{q_0, q_1, q_2, q_3\}$
2. $\Sigma = \{a, b\}$
3. $\Delta = \{0, 1\}$
4. $\delta : Q \times \Sigma \longrightarrow Q$
5. $\lambda : Q \longrightarrow \Delta$

Present state	Next state input = a	Next state input = b	Output
$\rightarrow q_0$	q_1	q_0	0
q_1	q_2	q_0	0
q_2	q_1	q_3	0
q_3	q_1	q_0	1

6. q_0 is the initial state.

Q.7.

Simulation (string: baab)

$\rightarrow \delta(q_0, baab)$

$\rightarrow \delta(q_0, aab)$

$\rightarrow \delta(q_1, ab)$

$\rightarrow \delta(q_2, b)$

$\rightarrow \delta(q_3)$

$\Rightarrow q_3$ counts 1

Q.8. Differentiate between Moore machine and Mealy machine.

Moore machine	Mealy machine
① Output depends upon Only the Present state.	① Output depends upon both the Present state and Present Input.
② Generally it has more states than mealy machines.	② Generally it has fewer states than Moore machine
③ The value of the output function is the function of the current state and the changes at the clock edges. whenever state changes occur.	③ The value of the output function is the function of the transitions and the changes, when the input logic on the present state is done.
④ Moore machine, more logic is required to decode the outputs resulting in more circuit delays. They generally react one clock cycle later.	④ Mealy machine reacts faster to the input. They generally react in the same clock cycle.