DIGITAL DESIGN
(CS-221)

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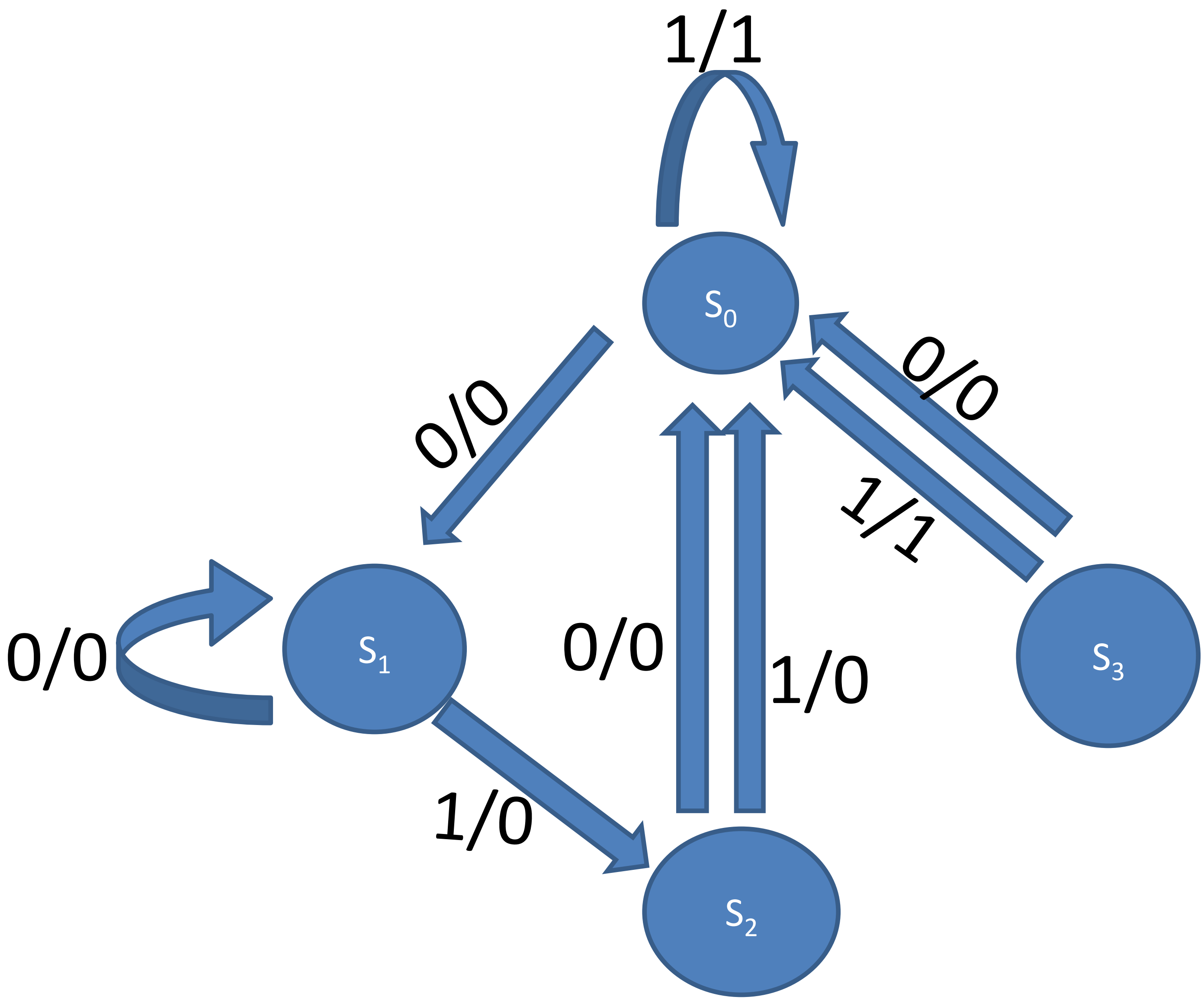
Solved Examples of **Moore** and **Mealy Machine**

Example 1: Design the combinational block for the following Mealy FSM.



PS Q_AQ_B	i/p a	NS Q_AQ_B	o/p y	J_AK_A	J_BK_B
00	0	01	0	0X	1X
00	1	00	1	0X	0X
01	0	01	0	0X	X0
01	1	11	0	1X	X0
10	0	00	0	X1	0X
10	1	00	1	X1	0X
11	0	00	0	X1	X1
11	1	00	0	X1	X1

Expression for J_A :

a \ $Q_A Q_B$	00	01	11	10
0	0X (0)	0X (2)	X1 (6)	X1 (4)
1	0X (1)	1X (3)	X1 (7)	X1 (5)

$J_A = Q_B.a$

$K_A = 1$

Expression for J_B :

a \ Q_AQ_B	00	01	11	10
0	1X (0)	X0 (2)	X1 (6)	0X (4)
1	0X (1)	X0 (3)	X1 (7)	0X (5)

$J_B = \overline{Q_A}\,.\overline{a}$

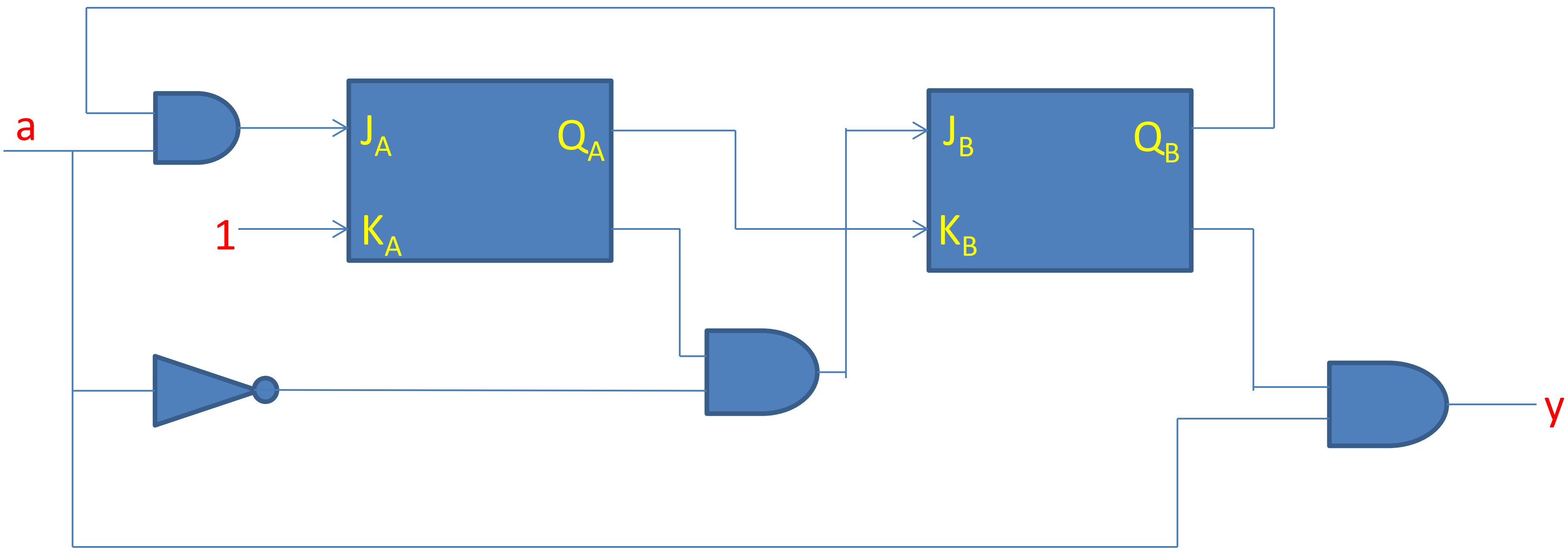
$K_B = Q_A$

Expression for ‘y’ :

a \ Q_AQ_B	00	01	11	10
0	0 (0)	0 (2)	0 (6)	0 (4)
1	1 (1)	0 (3)	0 (7)	1 (5)

$$Y = \overline{Q_B}.a$$

Circuit implementation:



Example 2: To design a circuit detecting three consecutive-1s using D-f/f. Set next state high when three consecutive-1s occur.

Solution: This is the Moore machine example.

Taking Four States:

S_0=State when no 1 seen;

S_1=State when one 1 seen;

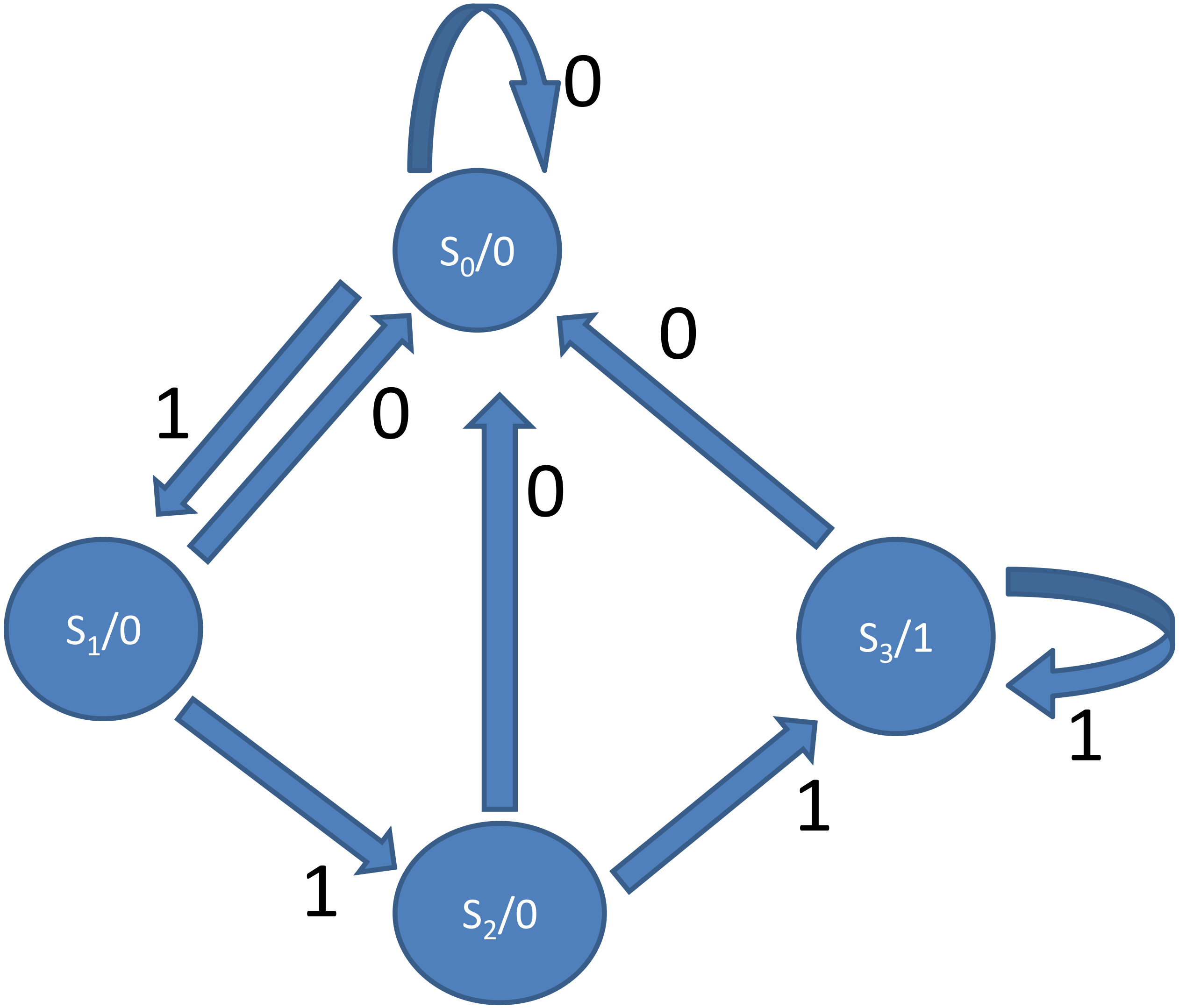
S_2=State when two 1s seen;

S_3=State when three or more 1s seen;

Assigning the following arbitrary(as the values don't affect the outputs) values to the states:

States	Values
S_0	11
S_1	10
S_2	01
S_3	00

The State Diagram:



Explanation:

Given the initial state S_0, when the input is 0, there will be no change in the number of 1s. When the input is 1, number of 1s will become one and the state changes to S_1. In both these cases, output will be 0 as number of consecutive 1s are still less than 3.

From here (state S_1) when input is 0, the next state will be S_0 again as we are checking for 3 or more consecutive 1s, which are not possible in this case. When input is 1, number of consecutive 1s will increase by one and next state will be S_2(here number of consecutive 1s will be 2).In these two cases also output will be 0 as number of consecutive 1s are still less than 3.

From S_2, when input is 0, chain of consecutive 1s will break again and it will move to state S_0. But if input is 1, number of consecutive 1s will change from two to three, moving to state S_3. But still output will be 0 in both the cases as the output of Moore machine is determined solely by its present state.

Now, in state S_3, whether input is 0 or 1, output will be 1 only as the output of Moore machine is determined solely by its present state. Only difference will be that of next state i.e. when input is 0, next state will be S_0 and will remain in state S_3 when input is 1.

Accordingly, the truth table formed:

Present State(PS)	i/p(input)	Next State(NS)	o/p(output)
Q_AQ_B	**a**	**Q_AQ_B**	**y**
0 0	0	1 1	1
0 0	1	0 0	1
0 1	0	1 1	0
0 1	1	0 0	0
1 0	0	1 1	0
1 0	1	0 1	0
0 0	0	1 1	0
0 0	1	1 0	0

The Karnaugh Maps:

For D_A and D_B:

a \ Q_AQ_B	**00**	**01**	**11**	**11**
0	11	11	11	11
1	00	00	10	01

From the Karnaugh map above, the derived expression for

a) $\mathbf{D_A} = \bar{a} + Q_A.Q_B$ b) $\mathbf{D_B} = \bar{a} + Q_A.\overline{Q}_B$

For output y:

a \ Q_AQ_B	**00**	**01**	**11**	**10**
0	1	0	0	0
1	1	0	0	0

Expression for $y = \overline{Q}_A.\overline{Q}_B$