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Class: BCSE II

Sem: Second

ASSIGNMENT - 01

Objective: Design an UP-Down (as selected by a control line) Decade counter using JK Flip Flop.

Theory: A decade counter counts from 0 to 9 and returns back to 0 after 9.

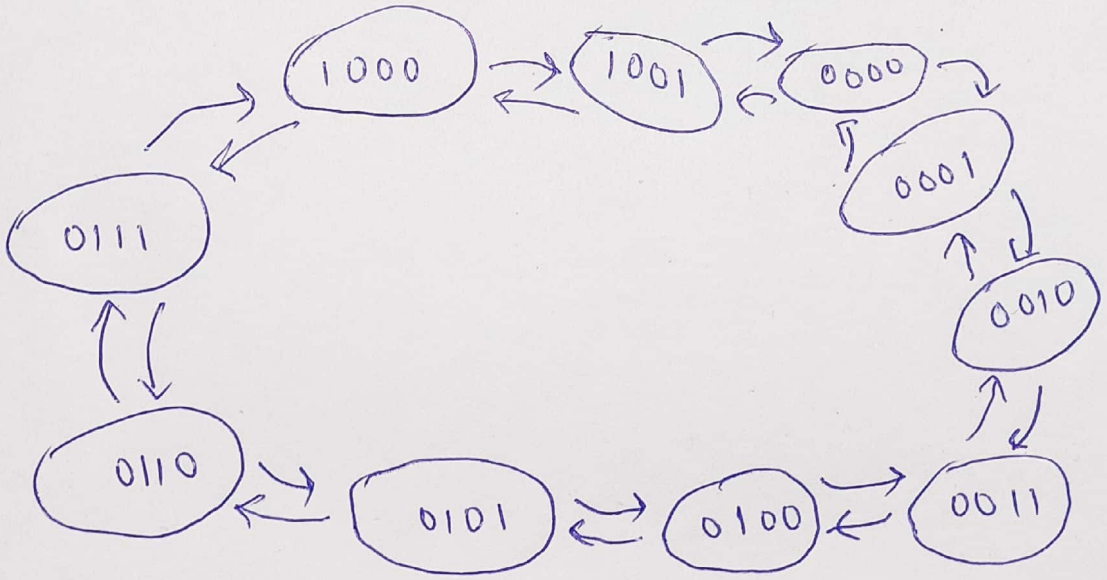
No. of states = 10

Range = 0 to 9

No. of flip flops = 4

A control line is used to control if the counter is UP or DOWN. when it is 0, the counter is UP and when it is 1, the counter is DOWN.

State Diagram:



Excitation Table of JK Flip Flop:

Q_n	Q_{n+1}	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

C.L	Present State				Next state				Flipflop Inputs							
M	Q_A	Q_B	Q_C	Q_D	Q_{A+1}	Q_{B+1}	Q_{C+1}	Q_{D+1}	J_A	K_A	J_B	K_B	J_C	K_C	J_D	K_D
0	0	0	0	0	0	0	0	1	0	X	0	X	0	X	1	X
0	0	0	0	1	0	0	1	0	0	X	0	X	0	X	X	1
0	0	0	1	0	0	0	1	1	0	X	0	X	X	0	1	X
0	0	0	1	1	0	1	0	0	0	X	1	X	X	1	X	1
0	0	1	0	0	0	1	0	1	0	X	X	0	0	X	1	X
0	0	1	0	1	0	1	1	0	0	X	X	0	1	X	X	1
0	0	1	1	0	0	1	1	1	0	X	X	0	X	0	1	X
0	0	1	1	1	1	0	0	0	1	X	X	1	X	1	X	1
0	1	0	0	0	1	0	0	1	X	0	0	X	0	X	1	X
0	1	0	0	1	0	0	0	0	X	1	0	X	0	X	X	1
1	0	0	0	0	1	0	0	1	1	X	0	X	0	X	1	X
1	1	0	0	1	1	0	0	0	X	0	0	X	0	X	X	1
1	1	0	0	0	0	1	1	1	X	1	1	X	0/1	X	1	X
1	0	1	1	1	0	1	1	0	0	X	X	0	0	X	X	1
1	0	1	1	0	0	1	0	1	0	X	X	0	X	0/1	1	X
1	0	1	0	1	0	1	0	0	0	X	X	0	0	X	X	1
1	0	1	0	0	0	0	1	1	0	X	X	1	1	X	1	X
1	0	0	1	1	0	0	1	0	0	X	0	X	X	0	X	1
1	0	0	1	0	0	0	0	1	0	X	0	X	X	1	1	X
1	0	0	0	1	0	0	0	0	0	X	0	X	0	X	X	1

Expressions:

$J_A = \Sigma m(7,16) + d(8,9,10,11,12,13,14,15,24,25,26,27,28,29,30,31)$

$K_A = \Sigma m(9,24) + d(0,1,2,3,4,5,6,7,10,11,12,13,14,15,16,17,18,19,20,21,22,23,26,27,28,29,30,31)$

$J_B = \Sigma m(3,24) + d(4,5,6,7,10,11,12,13,14,15,20,21,22,23,26,27,28,29,30,31)$

$K_B = \Sigma m(7,20) + d(0,1,2,3,8,9,10,11,12,13,14,15,16,17,18,19,22,23,26,27,28,29,30,31)$

$J_C = \Sigma m(1,5,20,24) + d(2,3,6,7,10,11,12,13,14,15,18,19,22,23,26,27,28,29,30,31)$

$K_C = \Sigma m(3,7,18,22) + d(0,1,4,5,8,9,10,11,12,13,14,15,16,17,20,21,24,25,26,27,28,29,30,31)$

$J_D = \Sigma m(0,2,4,6,8,16,18,20,22,24) + d(1,3,5,7,9,10,11,12,13,14,15,17,19,21,23,25,26,27,28,29,30,31)$

$K_D = \Sigma m(1,3,5,7,9,17,19,21,23,25) + d(0,2,4,6,8,10,11,12,13,14,15,16,18,20,22,24,26,27,28,29,30,31)$

K-Maps:

For J_A

when M=0

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	X	X	X	X
10	X	X	X	X

when M=1

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	1	0	0	0
01	0	0	0	0
11	X	X	X	X
10	X	X	X	X

$$\therefore J_A = M'Q_BQ_CQ_D + MQ_B'Q_C'Q_D'$$

For K_A

When M=0

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	X	X	X	X
01	X	X	X	X
11	X	X	X	X
10	0	1	X	X

when M=1

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	X	X	X	X
01	X	X	X	X
11	X	X	X	X
10	1	0	X	X

$$K_A = M'Q_D + MQ_D'$$

For J_B

When M = 0

$Q_A Q_B$ \ $Q_C Q_D$	00	01	11	10
00	0	0	1	0
01	X	X	X	X
11	X	X	X	X
10	0	0	X	X

When M = 1

$Q_A Q_B$ \ $Q_C Q_D$	00	01	11	10
00	0	0	0	0
01	X	X	X	X
11	X	X	X	X
10	1	0	X	X

$$J_B = M' Q_C Q_D + M Q_A Q_D'$$

For K_B

When M = 0

$Q_A Q_B$ \ $Q_C Q_D$	00	01	11	10
00	X	X	X	X
01	0	0	1	0
11	X	X	X	X
10	X	X	X	X

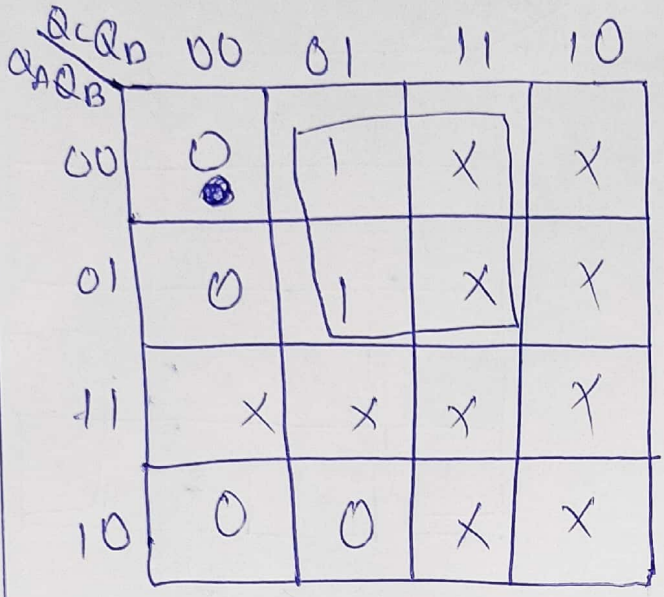
When M = 1

$Q_A Q_B$ \ $Q_C Q_D$	00	01	11	10
00	X	X	X	X
01	1	0	0	0
11	X	X	X	X
10	X	X	X	X

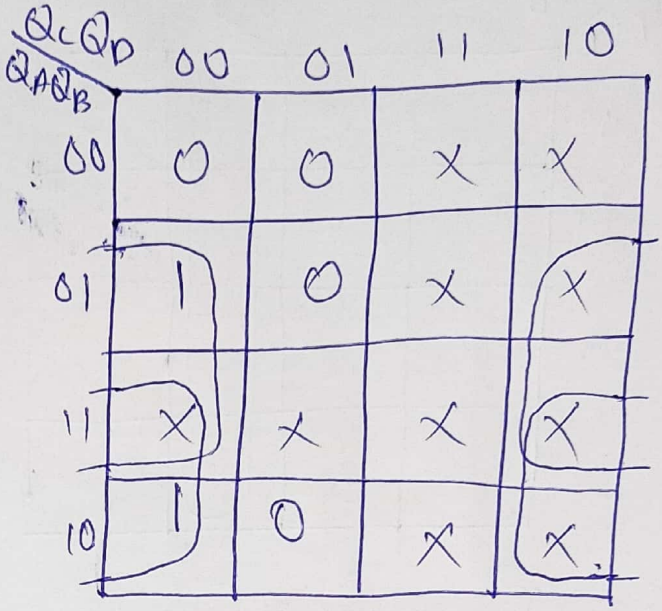
$$K_B = M Q_C' Q_D' + M' Q_C Q_D$$

For J_C:

when M = 0



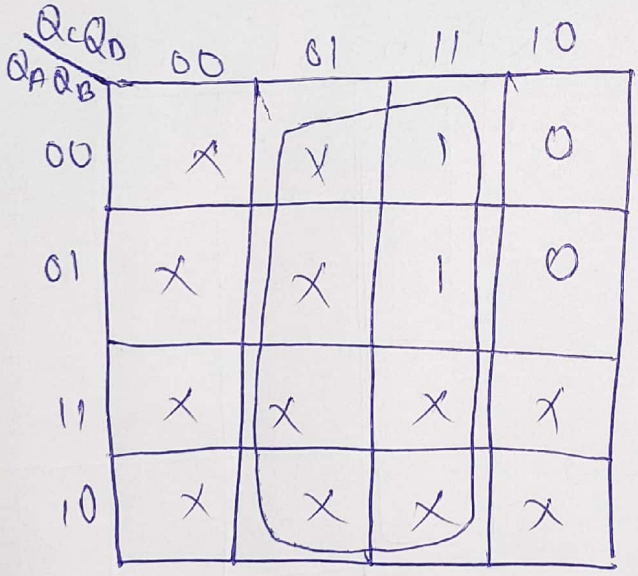
when M = 1



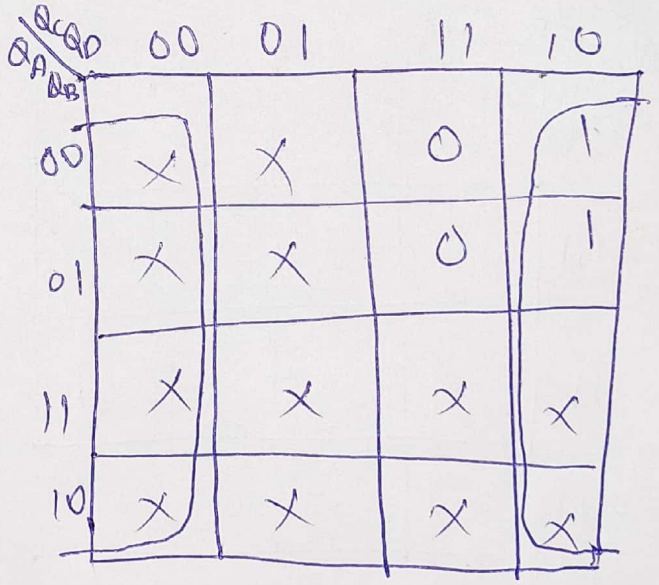
$$J_C = MQ_BQ_D' + MQ_AQ_D' + M'Q_A'Q_D$$

For K_C

when M = 0



when M = 1



$$K_C = M'Q_D + MQ_D'$$

For J_D :

when M=0

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	1	X	X	1
01	1	X	X	1
11	X	X	X	X
10	1	X	X	X

when M=1

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	1	X	X	1
01	1	X	X	1
11	X	X	X	X
10	1	X	X	X

$J_D = 1$

For K_D:

when M=0

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	X	1	1	X
01	X	1	1	X
11	X	X	X	X
10	X	1	X	X

when M=1

Q_AQ_B \ Q_CQ_D	00	01	11	10
00	X	1	1	X
01	X	1	1	X
11	X	X	X	X
10	X	1	X	X

$K_D = 1$

Final Expressions:

$$J_A = M Q_B' Q_C' Q_D' + M' Q_B Q_C Q_D$$

$$K_A = M Q_D' + M' Q_D$$

$$J_B = M Q_A Q_D' + M' Q_C Q_D$$

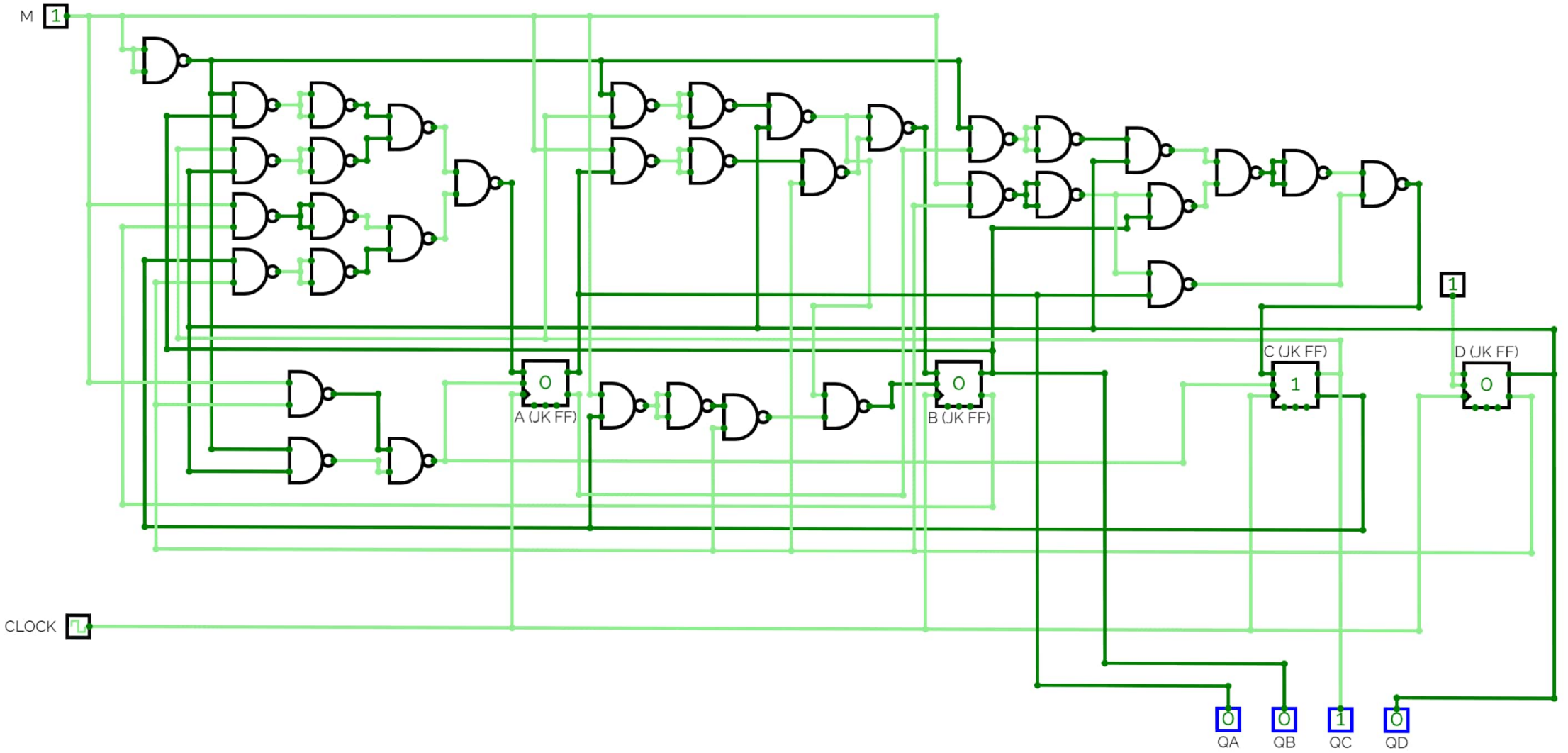
$$K_B = M Q_C' Q_D' + M' Q_C Q_D$$

$$J_C = M Q_A Q_D' + M Q_B Q_D' + M' Q_A' Q_D$$

$$K_C = M Q_D' + M' Q_D$$

$$J_D = 1$$

$$K_D = 1$$


M
1
CLOCK
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0
B (JK FF)
0
C (JK FF)
1
D (JK FF)
0
1
QA
0
QB
0
QC
1
QD
0