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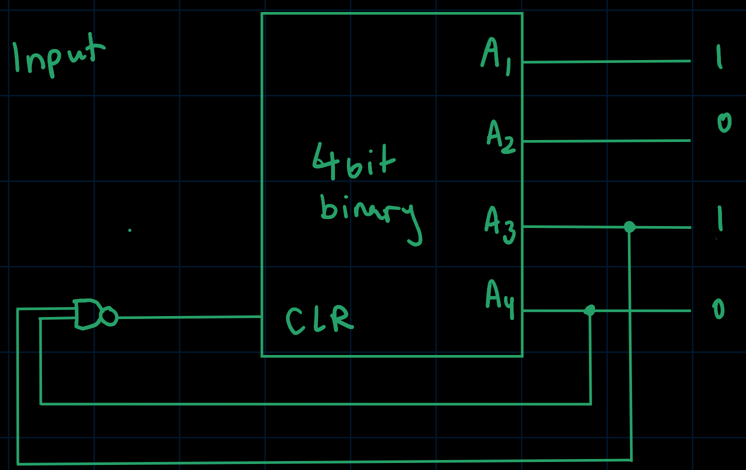
6.11 A ripple counter uses flip-flops that trigger on the positive edge of the clock. What will be the count if
a) The normal outputs of the flip-flops are connected to the clock;
b) The complement outputs of the flip-flops are connected to the clock?

a) Count will be 2^{n-1} where n is number of bits
b) Count will also be 2^{n-1}

6.13 Show that a BCD ripple counter can be constructed using a four-bit binary ripple counter with asynchronous clear and a NAND gate that detects the occurence of count 1010.



BCD counter 0→9
∴ 0000→1001

when counter is 1010,
it clears resets to 0000

6.19 The flip-flop input equations for a BCD counter using T flip-flops are given in Section 6.4. Obtain the input equations for a BCD counter that uses (a) JK flip-flop and (b) D flip-flops. Compare the three designs to determine which one is most efficient.

Present State				Next State				FF Inputs							
A_1	A_2	A_3	A_4	A_1	A_2	A_3	A_4	J_{A1}	K_{A1}	J_{A2}	K_{A2}	J_{A3}	K_{A3}	J_{A4}	K_{A4}
0	0	0	0	0	0	0	1	0	x	0	x	0	x	1	x
0	0	0	1	0	0	1	0	0	x	0	x	1	x	x	1
0	0	1	0	0	0	1	1	0	x	0	x	x	0	1	x
0	0	1	1	0	1	0	0	0	x	1	x	x	1	x	1
0	1	0	0	0	1	0	1	0	x	x	0	0	x	1	x
0	1	0	1	0	1	1	0	0	x	x	0	1	x	x	1
0	1	1	0	0	1	1	1	0	x	x	0	x	0	1	x
0	1	1	1	1	0	0	0	1	x	x	1	x	1	x	1
1	0	0	0	1	0	0	1	x	0	0	x	0	x	1	x
1	0	0	1	0	0	0	0	x	1	0	x	0	x	x	1

Present State				Next State				FF state			
A_1	A_2	A_3	A_4	A_1	A_2	A_3	A_4	D_{A1}	D_{A2}	D_{A3}	D_{A4}
0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	1	0	0	0	1	0
0	0	1	0	0	0	1	1	0	0	1	1
0	0	1	1	0	1	0	0	0	1	0	0
0	1	0	0	0	1	0	1	0	1	0	1
0	1	0	1	0	1	1	0	0	1	1	0
0	1	1	0	0	1	1	1	0	1	1	1
0	1	1	1	1	0	0	0	1	0	0	0
1	0	0	0	1	0	0	1	1	0	0	1
1	0	0	1	0	0	0	0	0	0	0	0

Kmap for J_{A1}

A_1A_2 \ A_3A_4	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	x	x	x	x
00	x	x	x	x

$J_{A1} = A_2A_3A_4$

Kmap for K_{A1}

A_1A_2 \ A_3A_4	00	01	11	10
00	x	x	x	x
01	x	x	x	x
11	x	x	x	x
00	0	1	x	x

$K_{A1} = A_4$

Kmap for J_{A2}

A_1A_2 \ A_3A_4	00	01	11	10
00	0	0	1	0
01	x	x	x	x
11	x	x	x	x
00	0	0	x	x

$J_{A2} = A_3A_4$

Kmap for K_{A2}

A_1A_2 \ A_3A_4	00	01	11	10
00	x	x	x	x
01	0	0	1	0
11	x	x	x	x
00	x	x	x	x

$K_{A_2} = A_3A_4$

Kmap for J_{A3}

A_1A_2 \ A_3A_4	00	01	11	10
00	0	1	x	x
01	0	1	x	x
11	x	x	x	x
00	0	0	x	x

$J_{A_3} = A_1'A_4$

Kmap for K_{A3}

A_1A_2 \ A_3A_4	00	01	11	10
00	x	x	1	0
01	x	x	1	0
11	x	x	x	x
00	x	x	x	x

$K_{A_3} = A_4$

Kmap for J_{A4}

A_1A_2 \ A_3A_4	00	01	11	10
00	1	x	x	1
01	1	x	x	1
11	x	x	x	x
00	1	x	x	x

$J_{A_4} = 1$

Kmap for K_{A4}

A_1A_2 \ A_3A_4	00	01	11	10
00	x	1	1	x
01	x	1	1	x
11	x	x	x	x
00	x	1	x	x

$K_{A_4} = 1$

$J_{A1} = A_2A_3A_4$ $\quad K_{A1} = A_4$

$J_{A2} = A_3A_4$ $\quad K_{A2} = A_3A_4$

$J_{A3} = A_1'A_4$ $\quad K_{A3} = A_4$

$J_{A4} = 1$ $\quad K_{A4} = 1$

# of AND gates = 4

Total Gates = 4

Kmap for D_{A1}

A_1A_2 \ A_3A_4	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	x	x	x	x
00	1	0	x	x

$D_{A1} = A_1A_4' + A_2A_3A_4$

Kmap for D_{A2}

A_1A_2 \ A_3A_4	00	01	11	10
00	0	0	1	0
01	1	1	0	1
11	x	x	x	x
00	0	0	x	x

$D_{A2} = A_2A_3' + A_2A_4' + A_4A_2A_1$

$= A_2(A_3' + A_4') + A_2A_3A_4$

$= A_2(A_3A_4)' + A_2(A_3A_4)$

$= A_2 \oplus A_3A_4$

Kmap for D_{A3}

A_1A_2 \ A_3A_4	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	x	x	x	x
00	0	0	x	x

$D_{A3} = A_3A_4' + A_1'A_3'A_4$

Kmap for D_{A4}

A_1A_2 \ A_3A_4	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	x	x	x	x
00	1	0	x	x

$D_{A4} = A_1'$

$D_{A1} = A_1A_4' + A_2A_3A_4$

$D_{A2} = A_2 \oplus A_3A_4$

$D_{A3} = A_3A_4' + A_1'A_3'A_4$

$D_{A4} = A'$

\# of AND gates = 5

\# of OR gates = 2

\# of XOR gates = 1

Total gates = 8 > 4

∴ JK is more efficient

6.27 Using JK Flip-flops:

a) Design a counter with the following repeated binary sequence 0,1,2,3,4,5,6

b) Draw the Logic Diagram of the counter

Present State			Next State			FF inputs					
x	y	z	$x(t+1)$	$y(t+1)$	$z(t+1)$	J_x	K_x	J_y	K_y	J_z	K_z
0	0	0	0	0	1	0	x	0	x	1	x
0	0	1	0	1	0	0	x	1	x	x	1
0	1	0	0	1	1	0	x	x	0	1	x
0	1	1	1	0	0	1	x	x	1	x	1
1	0	0	1	0	1	x	0	0	x	1	x
1	0	1	1	1	0	x	0	1	x	x	1
1	1	0	0	0	0	x	1	x	1	0	x
1	1	1	x	x	x	x	x	x	x	x	x

Kmap for J_x

x \ yz	00	01	11	10
0	0	0	1	0
1	x	x	x	x

$J_x = yz$

Kmap for J_y

x \ yz	00	01	11	10
0	0	1	x	x
1	0	1	x	x

$J_y = z$

Kmap for J_z

x \ yz	00	01	11	10
0	1	x	x	1
1	1	x	x	0

$J_z = x' + y'$

Kmap for K_x

x \ yz	00	01	11	10
0	x	x	x	x
1	0	0	x	1

$K_x = y$

Kmap for K_y

x \ yz	00	01	11	10
0	x	x	1	0
1	x	x	x	1

$K_y = x + z$

Kmap for K_z

x \ yz	00	01	11	10
0	x	1	1	x
1	x	1	x	x

$K_z = 1$

Present State			Next State			FF inputs					
x	y	z	$x(t+1)$	$y(t+1)$	$z(t+1)$	J_x	K_x	J_y	K_y	J_z	K_z
1	1	1	0	0	0	1	1	1	1	0	1