University of New Brunswick

Computer Science

CS3853: Computer Architecture and Organization

Instructor: Joannah Nanjekye, jnanjeky@unb.ca

Due Date: August 07, 2024 —- 11:59 PM

ASSIGNMENT 3

Submission instructions:

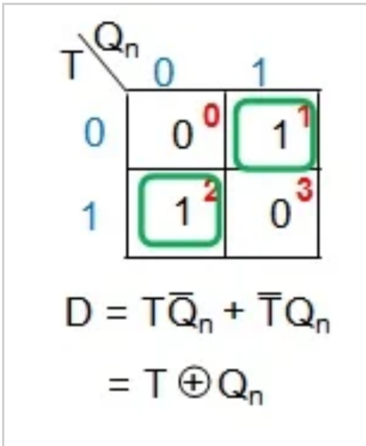
- Submit a pdf file to the Desire2Learn dropbox

Problem 1. Consult the class notes (slides) and discussion on flip-flops to implement the following. In each case use any additional logic gates that are required.

- A T-FF using a D-FF[1]

  Solution: 6 points — 2 points for transition diagram, 2 points for state table, 2 points for the kmap and final expressions, I dont include these in my solutions

T Input	Outputs		D Input
	Present State	Next State	
T	Q_n	Q_{n+1}	D
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

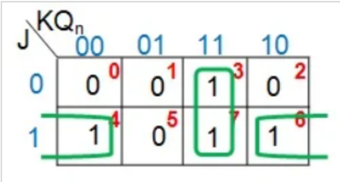


[1] https://www.allaboutcircuits.com/technical-articles/conversion-of-flip-flops-part-iv-d-flip-flops/

- A JK-FF using a T-FF[2]

  Solution: 6 points — 2 points for transition diagram, 2 points for state table, 2 points for the kmap and final expressions

JK Inputs		Outputs		T Input
		Present State	Next State	
J	K	Q_n	Q_{n+1}	T
0	0	0	0	0
0	0	1	1	0
0	1	0	0	0
0	1	1	0	1
1	0	0	1	1
1	0	1	1	0
1	1	0	1	1
1	1	1	0	1



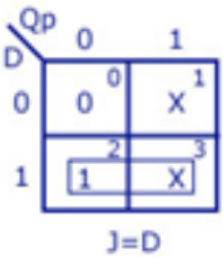
$$T = J\bar{Q}_n + KQ_n$$

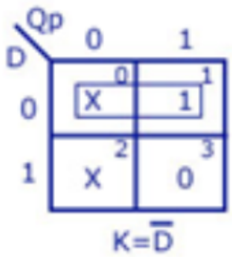
- A D-FF from a JK-FF[3]

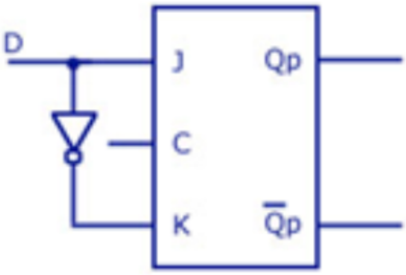
  Solution: 6 points — 2 points for transition diagram, 2 points for state table, 2 points for the kmap and final expressions

[2]https://www.allaboutcircuits.com/technical-articles/conversion-of-t-flip-flops-part-v/
[3]https://www.electronics-tutorial.net/sequential-logic-circuits/toggle-flip-flop/

D	q	q^*	J	K
0	0	0	0	x
0	1	0	x	1
1	0	1	1	x
1	1	0	x	0







- A JK-FF using a D-FF

Solution: 6 points — 2 points for transition diagram, 2 points for state table, 2 points for the kmap and final expressions

J	K	q	q^*
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Kq

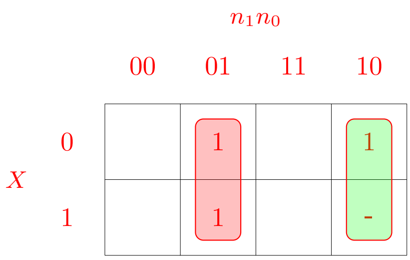
J \ Kq	00	01	11	10
0		1		
1	1	1		1

$F(J,K,q) = \overline{K}q + J\overline{q}$

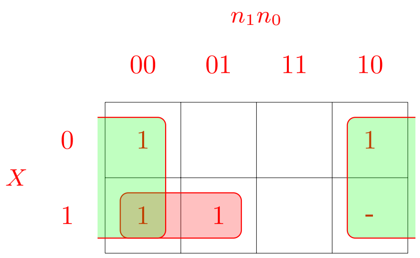
Problem 2. Design a synchronous counter using D-FFs and one input x. If x = 0 it counts 1,2,3, 0, 1,2 . . .; if x = 1 it counts 1, 3, 0, 1, 3, ... Assume that x only changes in 1 or 3 (in which case there is one combination that will never occur – state 2 and x = 1).

Solution: 12 points — 3 points for transition diagram, 3 points for state table, 3 points for the kmap and final expressions for D_1, and 3 points for the kmap and final expressions for D_2

Current		**x = 0**				**x = 1**			
n_1	n_0	n_1	n_0	D_1	D_0	n_1	n_0	D_1	D_0
0	0	0	1	0	1	0	1	0	1
0	1	1	0	1	0	1	1	1	1
1	0	1	1	1	1	x	x	x	x
1	1	0	0	0	0	0	0	0	0



$D_1 = \overline{n_1}n_0 + n_1\overline{n_0}$



$D_0 = X\overline{n_1} + \overline{n_0}$