Computer Architecture and Programming Languages
Jacobs University Bremen
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Course: CO20-320241
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Homework 3

Problem 3.1

Solution:
A) Distributive rule: $(M+N)(!M+P)(!N+!P) = (M*!M+P*M+N*!M+NP)(!N+!P)$
Complement:
$(M*!M+P*M+N*!M+NP)(!N+!P) = (P*M+N*!M+NP)(!N+!P)$
Distributive rule:
$(P*M+N*!M+NP)(!N+!P) = (!N*P*M+!N*N*!M+!N*N*P+!P*P*M+!P*N*!M+!P*N*P)$
Complement:
$(!N*P*M+!N*N*!M+!N*N*P+!P*P*M+!P*N*!M+!P*N*P) = (!N*P*M+!P*N*!M)$

B) Distributive rule:
$!A*B*!C+A*B*!C+B*!C*D = B*!C*(!A+A+D)$
Complement:
$B*!C*(!A+A+D) = B*!C*(1+D)$
De morgan:
$B*!C*(1+D) = B*!C$

C) De morgan:
$!((M+N+P)*Q) = !(M+N+P)+!Q$
DE morga and associativen:
$!(M+N+P)+!Q = !M*!N*!P+!Q$

d)De morgan and associative:
$!((A*B*C)+(D*E*F)) = !(A*B*C)*!(D*E*F)$

De morgan and associative:
$(!A+!B+!C)*(!D+!E+!F)$

e)De morgan and associative:
$!((A*!B)+(C*!D)+(E*F)) = !(A*B)*!(C*!D)*!(E*F) =$
De morgan and associative:
$(!A+!B)*(!C+D)*(!E+!F)$

f)De morgan and associative:
$!(!(A+B*!C)+D*!(E+!F)) = (A+B*!C)*!(D*!(E+!F)) =$
De morgan and associative:
$(A+B*!C)*(!D+(E+F))$

Problem 3.2

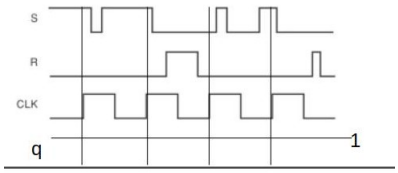
Solution:
By observing the given circuit we can conclude that it corresponds to the following expression:
$(\overline{A}*\overline{B}*\overline{C})+(A*\overline{B}*\overline{C})+(\overline{A}*\overline{B}*D)$
Constructing the table:

	$\overline{C}\,\overline{D}$	$\overline{C}D$	$C\,D$	$C\overline{D}$
$\overline{A}\overline{B}$	1	1	1	0
$\overline{A}B$	0	0	0	0
$A\,B$	0	0	0	0
$A\overline{B}$	1	1	0	0

From this we can conclude we have 2 unique loops:
(0,0),(0,1),(3,0),(3,1)
(0,1), (0,2)
Therefore the equation is $\overline{B}*\overline{C}+\overline{A}*\overline{B}*D$

Problem 3.3

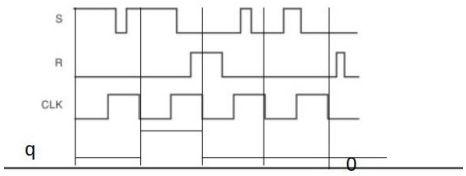
Solution:



S	R	CLK	Q
0	0	UP	Q_0
1	0	UP	1
0	1	UP	0
1	1	UP	Ambigous

Problem 3.4

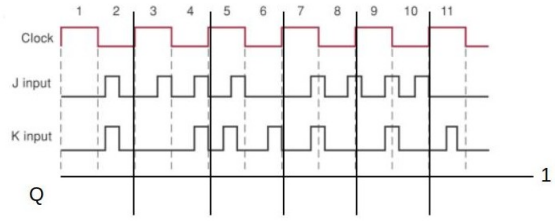
Solution:



S	R	CLK	Q
0	0	DOWN	Q_0
1	0	DOWN	1
0	1	DOWN	0
1	1	DOWN	Ambigous

Problem 3.5

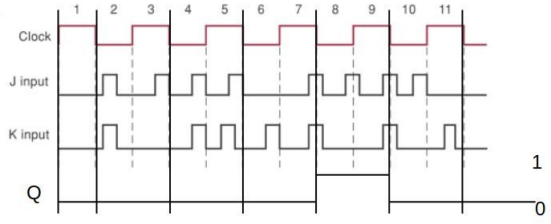
Solution:



S	R	CLK	Q
0	0	UP	Q_0(No change)
1	0	UP	1
0	1	UP	0
1	1	UP	$\overline{Q_0}$(toggles)

Problem 3.6

Solution:



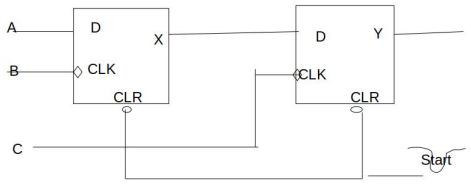
J	K	CLK	Q
0	0	DOWN	Q_0(No change)
1	0	DOWN	1
0	1	DOWN	0
1	1	DOWN	$\overline{Q_0}$(toggles)

Problem 3.7

Solution:

A) Let's start analyzing from the back. We want Y to get HIGH. We observe that it is a J-K flip flop, with grounded K. That means K = 0 for ever. Assuming the flip flop react on the positive going transitions, we want scenario where input J is HIGH, and timer to react after it, noticing the change. So what we want is J,C going high in this order. (According to state table from previous exercises). IN order J to get HIGH, we want X to get high. For that the situation is indentical, so we want to get A, then B HIGH, so we can register the change, and output HIGH at X, that will go to another J, and C will get HIGH, and after that Y will end up being high. So the order is A, B, C.

B)Since, the signal is connected to the CLR asynchrous input, it makes the X and Y outputs 0, it wipes it immideately.It is low input, so low start will set outputs to 0, "restarting" them.



C)