Introduction to Digital Computer Theory

Homework 9 - *flip flops, counters, shift registers, and pulse*

Instructions:

- Show all work to receive full credit.

Reference

Function Table – NOR S-R Flip flop				
Inputs		**Outputs**		**Comments**
S	**R**	**Q**	**Q~**	
0	0	Q	Q~	No Change
0	1	0	1	Reset
1	0	1	0	Set
1	1	Invalid		

Function Table – J-K Flip flop				
Inputs		**Outputs**		**Comments**
J	**K**	**Q**	**Q~**	
0	0	Q	Q~	No Change
0	1	0	1	Reset
1	0	1	0	Set
1	1	Q~	Q	Toggle, invert the previous state

Function Table – D Flip flop				
Input		**Outputs**		**Comments**
D	**Clock**	**Q**	**Q~**	
0	0	Q	Q~	No Change
0	1	0	1	Reset
1	0	Q	Q~	No Change
1	1	1	0	Set

Transition at output	PRESENT State Q(N)	NEXT State Q(N+1)	J	K
0 → 0	0	0	0	X
0 → 1	0	1	1	X
1 → 0	1	0	X	1
1 → 1	1	1	X	0
J-K FF excitation table				

555 Timer

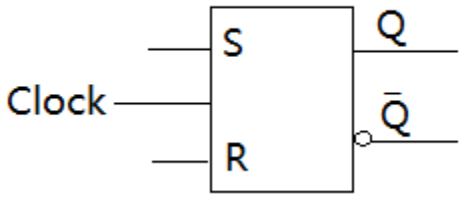
$T_{HI} = 0.693*(R1+R2)*C1$

$T_{LO} = 0.693(R2)*C1$

Duty cycle = $(T_{HI} / \text{Period})*100\%$

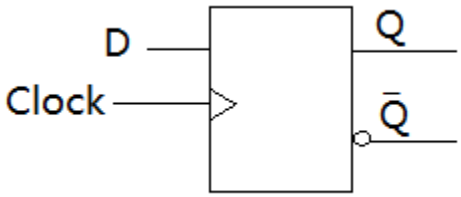
Period = $T = T_{HI} + T_{LO}$

Question 1) For a given S-R FF, find the output Q and Q~ assuming that $Q_{initial} = 1$



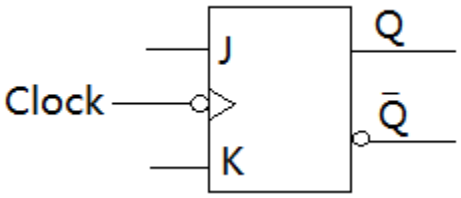
Clock								
	0	1	2	3	4	5	6	7
S								
	0	1	2	3	4	5	6	7
R								
	0	1	2	3	4	5	6	7
Q								
	0	1	2	3	4	5	6	7
Q~								
	0	1	2	3	4	5	6	7

Question 2) For the following D-FF, sketch output Q assuming Qinitial = 0



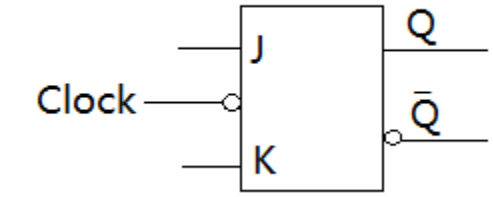
Clock								
	0	1	2	3	4	5	6	7
D								
	0	1	2	3	4	5	6	7
Q								
	0	1	2	3	4	5	6	7
Q~								
	0	1	2	3	4	5	6	7

Question 3) For the following J-K-FF, sketch output Q assuming Qinitial = 1



Clock									
	0	1	2	3	4	5	6	7	8
J									
	0	1	2	3	4	5	6	7	8
K									
	0	1	2	3	4	5	6	7	8
Q									
	0	1	2	3	4	5	6	7	8
Q~									
	0	1	2	3	4	5	6	7	8

Question 4) For the following J-K-FF, sketch output Q assuming Qinitial = 0



Clock									
	0	1	2	3	4	5	6	7	8
J									
	0	1	2	3	4	5	6	7	8
K									
	0	1	2	3	4	5	6	7	8
Q									
	0	1	2	3	4	5	6	7	8
Q~									
	0	1	2	3	4	5	6	7	8

Question 5) Design a synchronous counter that will display odd number as the following:

1➔3➔5➔6 repeats (COUNTER SEQUENCE)

Step 1: Write and sketch the sequence of the synchronous counter (3 points)

Step 2 and 3: Construct a truth table of the transition state with the PRESENT state and the NEXT state, and complete the J-K input for each flip flop using sequence diagram from Step 1.

	PRESENT state			NEXT state			J-K State					
Decimal	**C**	**B**	**A**	**C**	**B**	**A**	J_C	K_C	J_B	K_B	J_A	K_A
0	0	0	0									
1	0	0	1									
2	0	1	0									
3	0	1	1									
4	1	0	0									
5	1	0	1									
6	1	1	0									
7	1	1	1									
Circuit excitation table for sequence 1,3,5,6												

Step 4: Create a k-map table for each J and K input and find the SOP equation of each.

J_C

	$\overline{C}$	C
$\overline{A}\overline{B}$		
$\overline{A}B$		
AB		
$A\overline{B}$		

SOP :

J_B

	$\overline{C}$	C
$\overline{A}\overline{B}$		
$\overline{A}B$		
AB		
$A\overline{B}$		

SOP:

J_A

	$\overline{C}$	C
$\overline{A}\overline{B}$		
$\overline{A}B$		
AB		
$A\overline{B}$		

SOP:

K_C

	$\overline{C}$	C
$\overline{A}\overline{B}$		
$\overline{A}B$		
AB		
$A\overline{B}$		

SOP :

K_B

	$\overline{C}$	C
$\overline{A}\overline{B}$		
$\overline{A}B$		
AB		
$A\overline{B}$		

SOP:

K_A

	$\overline{C}$	C
$\overline{A}\overline{B}$		
$\overline{A}B$		
AB		
$A\overline{B}$		

SOP:

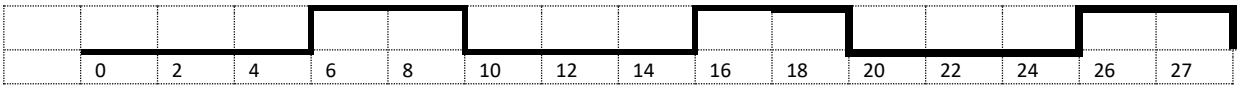
Step 5: Complete and sketch the counter circuit using the SOP equation found in **step** 4

Question 6) For the following pulse, find:

a. Period

b. Frequency

c. Duty cycle

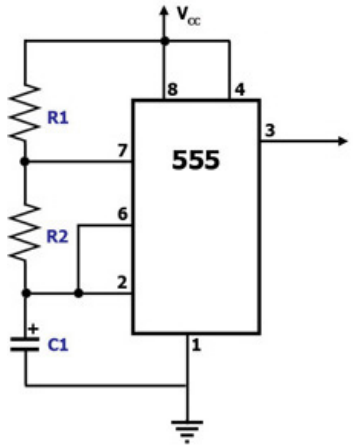


Question 7) For the following 555 timer, R1 = 3.6 Ω, R2 = 2 Ω, and C1 = 0.25 F, find:

a. Period

b. Frequency

c. Duty cycle



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