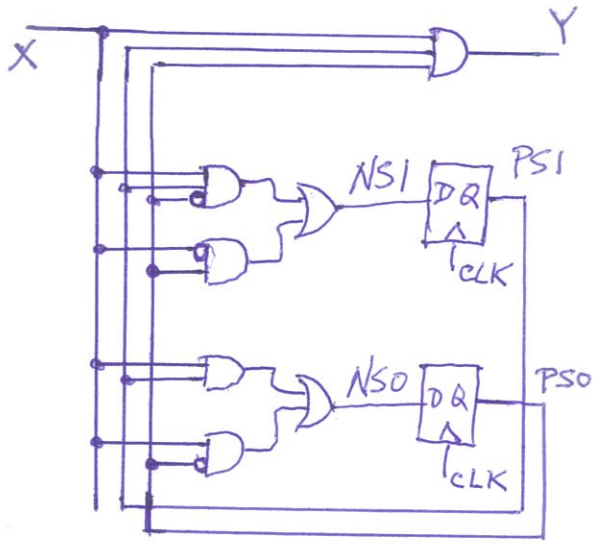
CS2101 Midterm II

Date: 3:30-5:10pm, Thursday, May 21, 2015

1. (40pt) Analyze the FSM below

i. (12pt) Find next state function and output function

- NS1 = f1 (PS1, PS0, X)
- NS0 = f2 (PS1, PS0, X)
- Y = f3(PS1, PS0, X)



ii. (13pt) Write state transition table

Truth Table Format

X	PS1	PS0	NS1	NS0	Y
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

*Hint: Three 1s in Column NS1 & NS0; One 1 in Column Y

Symbolic State Format

PS	NS		Y	
	X = 0	X = 1	X = 0	X = 1
A (00)				
B (01)				
C (10)				
D (11)				

iii. (5pt) Draw symbolic state transition diagram. It's a Mealy machine with four states and eight transitions.

iv. (5pt) Find state transition S and output stream Y given input stream X. Assume initial state A.

X	1	0	1	1	1	0	1	1	0	1	1	1	0	0	1	1	0	0
S	A																	
Y																		

v. (5pt) Describe its functionality

2. (35pt) Design an FSM that has one input X and one output Y. Y should output "1" when the FSM sees the end of a string of 1s; and "0" otherwise. E.g.,

X: 0001 0111 0011 00

Y: 0000 1000 1000 10

i. (10pt) Draw symbolic state transition diagram. Use Mealy style machine with two states, A and B, where A is the initial state.

ii. (5pt) Write state transition table.

iii. (5pt) Assign binary codes to states (A ← "0", B← "1") and write state transition table in truth table form.

iv. (5pt) Define next state function NS = f (PS, X)

v. (5pt) Define output function Y = g(PS, X)

vi. (5pt) Draw logic gate circuit diagram

3. (10pt) A positive-edge-triggered D-type flip-flop has following timing spec

Set-up time constraint (t_s) = 35ps

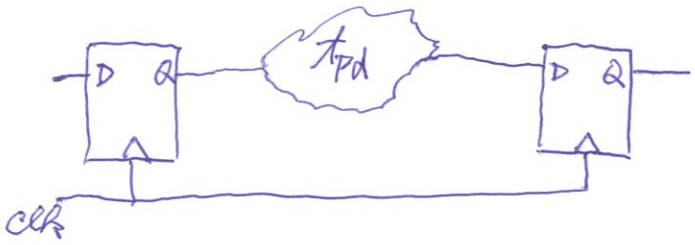
Hold time constraint (t_h) = 20ps

Contamination delay (t_{cCQ}) = 10ps

Propagation delay (t_{dCQ}) = 25ps

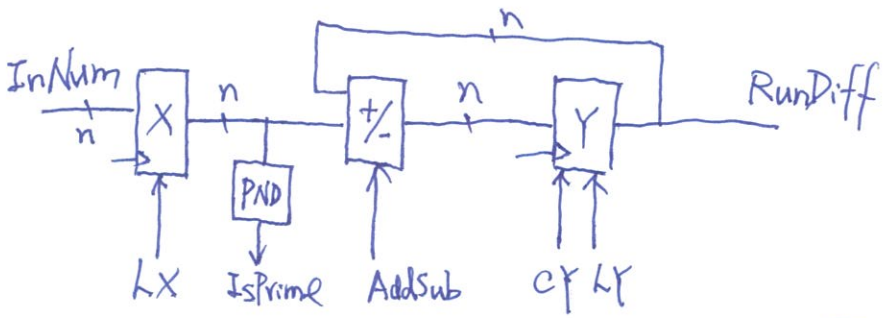
i. When combinational delay tpd = 140ps. How fast can the system being clocked (in GHz)?

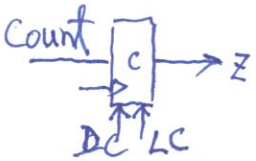
ii. What is the minimal value of tpd to guarantee no hold-time violation?

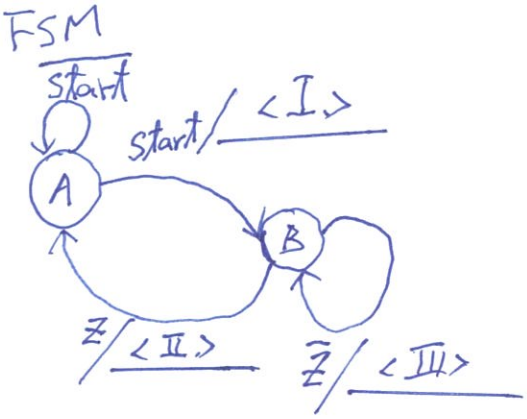


4. (15pt) Given a datapath below and an incomplete controlling FSM that calculates the running difference between the sum of prime numbers and sum of non-prime numbers. Write actions associated with each of three transitions. E.g.,

Start	0	1	0	0	0	0	0	0	0	0	0	0
Count	-	8	-	-	-	-	-	-	-	-	-	-
InNum	-	-	2	5	6	8	7	11	14	17-	-	-
RunDiff	-	-	0	2	7	1	-7	0	11	-3	14	-
Done	0	0	0	0	0	0	0	0	0	0	1	-







FSM Input & Output:

Start: Begin Operation

Done: Job is done

Datapath Input and Output:

Count: Number of Input Data to be processed

InNum: Input Port of Data

RunDiff: Running Difference

Command Signals to Datapath:

LC: Load Counter C from input "Count"

~~CC: Clear Counter C to 0~~ DC : Down Count C

LX: Load Register X

CY: Clear Register Y

LY: Load Register Y

AddSub: 0 for Addition; 1 for Subtraction

Status Signals from Datapath:

IsPrime: The Value of Register X is Prime

Z: The Value of the Counter is zero

1. <i>

$$NS1 = X \cdot PS1 \cdot \overline{PS0} \mid \bar{X} \cdot PS0$$

$$NS0 = X \cdot PS1 \mid X \cdot \overline{PS0}$$

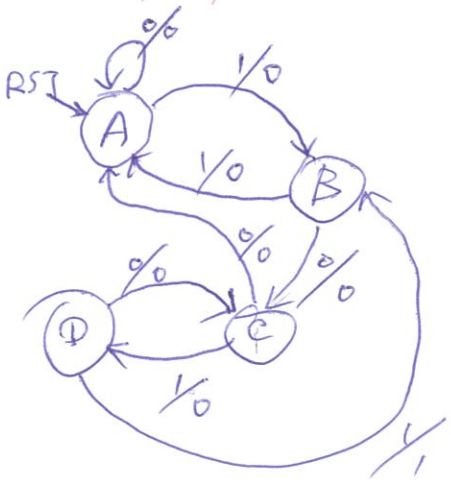
$$Y = X \cdot PS1 \cdot PS0$$

<ii>

X	PS1	PS0	NS1	NS0	Y
0	0	0	0	0	0
0	0	1	1	0	0
0	1	0	0	0	0
0	1	1	1	0	0
1	0	0	0	1	0
1	0	1	0	0	0
1	1	0	1	1	0
1	1	1	0	1	1

PS	X=0	X=1	Y=0	Y=1
A	A	B	0	0
B	C	A	0	0
C	A	D	0	0
D	C	B	0	1

<iii>



<iv>

X: 1 0 1 1 1 0 1 1 0 1 1 1 0 0 1 1 0 0

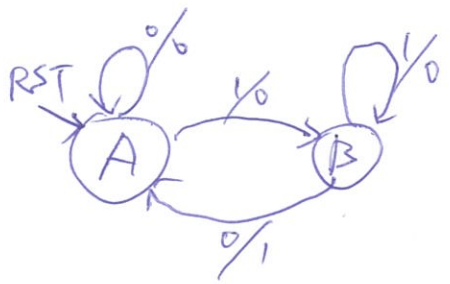
S: A B C D B A A B A A B A A A A B A A

Y: 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

<v> It detects 1st "1011".

It was meant to detect all "1011". if B → B is changed to B → B.

2. <i>



<ii>

PS	NS X=0	NS X=1	Y X=0	Y X=1
A	A	B	0	0
B	A	B	1	0

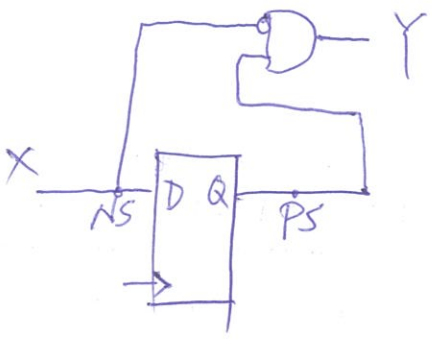
<iii>

X	PS	NS	Y
0	0	0	0
0	1	0	1
1	0	1	0
1	1	1	0

<iv> $NS = X$

<v> $Y = \bar{X} \cdot PS$

<vi>



3. <i> $t_{cycle} \geq t_{dCQ} + t_{pd} + t_s$

$= 25 + 140 + 35$

$= 200\ ps$

$f_{req} = \frac{1}{t_{cycle}} \leq \frac{1}{200 \times 10^{-12}} = 5\ GHz$ ... Max Speed

<ii> $t_{cCQ} + t_{pd} \leq t_h$

$10 + t_{pd} \leq 20$

$t_{pd} \leq 10\ ps$ --- Min Path delay to meet hold time Constraint

contamination

4.

	LC	DC	LX	CY	LY	AddSub	Done
<I>	1	0	X	1	0	X	0
<II>						X	1
<III>	0	1	1	0	1	$\overline{IsPrime}$	0

0(不做)跟X(don't care)的區別: 用"別人問你"去想