CSE 140 Midterm 2 version A
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Fall 2015

Name of the person on your left: ________________________________
Name of the person on your right: ________________________________

- Do not start the exam until you are told.
- Write your name and PID at the top of every page. Write the names of people on your left and right on the first page.
- Turn off and put away all your electronics. This is a closed-book, closed-notes. You may only refer to one 8 ½ x 11” page of your handwritten notes.
- By turning in this exam for grading you are stating that you have followed the UCSD’s academic honesty policies. Do not look at anyone else’s exam or talk to anyone but an exam proctor.
- If you have a question, raise your hand and an exam proctor will come to you.
- You have 80 minutes to finish the exam. When the time is finished, you must stop writing.

Write your answers in the space provided. To get the most partial credit, clearly show all the steps of your work. Full credit may not be given for correct answers with no work shown.

<table>
<thead>
<tr>
<th></th>
<th>1. 10 points</th>
<th>2. 10 points</th>
<th>3. 20 points</th>
<th>4. 20 points</th>
<th>5. 20 points</th>
<th>6. 20 points</th>
<th>Total (100 pts.)</th>
</tr>
</thead>
</table>
Problem 1 (10pts)
Timing characteristics of the components in the circuit below are as follows:

Flip flop: PD – 60ps, CD – 30ps, setup time – 35ps, hold time – 40ps
Logic gates (AND, OR, XOR, INV, NOR): PD – 35ps, CD – 25ps
Half adder: PD – 60ps, CD – 50ps
Clock skew: ZERO

PD: Propagation Delay; CD: Contamination Delay

(a) What is the maximum clock frequency of operation for this circuit?

(b) Is the hold constraint met? If not, how would you ensure it is?
**Problem 2** (10pts)
The counter shown below goes through a repeating sequence starting from 0000.

![Diagram of a counter circuit](image)

(a) How many clock cycles does it take before the sequence repeats? List all the transitions in the sequence.

(b) Derive a Boolean expression that outputs a logic ‘1’ when a palindrome is detected on the current value of “WXYZ”. List all palindromes that you observe in the first 10 transitions of the sequence.

A palindrome is a string which reads the same in both directions. For example, 10101 is a palindrome whereas 1100 is not as it is 0011 read backwards.
Problem 3 (20pts)
Design a Mealy FSM with minimum number of states that outputs a logic one if the input sequence received to that point in the time is divisible by 8. The bits that are received sooner are the more significant bits, for example number eleven is received as 1, 0, 1, 1. For example:
sequence: (MSB) 01000101011
output: 10001000000

(a) Draw the state diagram for the FSM.

(b) Provide an excitation table. Use binary encoding for the states, so state S0=00, S1=01, S2=10 etc.
(c) Implement the circuit for the MSB of the next state logic.
Problem 4 (20pts)
For the given circuit, draw the waveforms for outputs ‘A’ and ‘B’ based on the given signals ‘inp’ and ‘clk’. Assume that all circuits have near zero delay.
Problem 5 (20 pts)
Design an ALU with three 8-bit operands A, B and C and control inputs x, y and z, which implements the bitwise operations described in the table. You must use one of each of the following components and minimum number of other gates.

- 8:1 MUX
- 8-bit adder
- 2:1 MUX

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
<th>z</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S = A'B OR AC</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>S = A + B (Addition)</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>S = B XNOR C</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>S = AB</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>S = B XOR C</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>S = NOT A</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>S = A' OR AC</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>S = (AB)'</td>
</tr>
</tbody>
</table>
Problem 6 (20pts)
The following pattern detector has an input $B$. Once it detects a pattern, it sets $OUT$ equal to ‘1’. Use the partially filled out state diagram and state table to do the following:

(a) Fill in the missing entries in the state table and complete the FSM.

$S_1S_0$ is the encoding of the state. $S_1^+S_0^+$ is the next state.

(b) Which pattern is detected by this FSM?
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