CDA 3103 – Computer Organization and Logic

Midterm, Spring 2014

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

PID:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Instructions

* Write your name and PID on each page
* Be lucid and neat
* Justify all your answers
* 75 minutes
* Closed book, Closed notes
* Non-graphing calculator permitted

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Question 1 – 4 points

The output of a combinational circuit depends on

1. Present inputs only
2. Past inputs only
3. Both present and past inputs
4. Present outputs only

**ANS: (A) Present inputs only, because there is no feedback in the combinational circuit. The output is completely defined by it’s inputs.**

Question 2 – 4 points

The output of a sequential circuit depends on

1. Present inputs only
2. Past inputs only
3. Both present and past inputs
4. Present outputs only

**ANS: (C) Both present and past inputs, because there is a feedback from the outputs to the inputs. The output is dependent on the inputs coming in AND the previous input.**

Question 3 – 4 points

The clock signals are used in sequential logic circuits to

1. Tell the time of day
2. Tell how much time has elapsed since the system was turned on
3. Carry parallel data signals
4. Synchronize events in various parts of the system

**ANS: (D) Synchronize events in various parts of the system, because clock systems are also called synchronous systems. The clock dictates when the circuit is active, either on the rise or fall of the clock edge (s\_6 Sequential PPT).**

Question 4 – 4 points

A Set-Reset Latch is:

1. Always synchronous
2. Always asynchronous
3. Asynchronous without a clock signal
4. Synchronous without a clock signal

**ANS: (B) Always Asynchronous, because is only relies on the state of S and R, or the two signals being send in. After that it’s just a feedback loop.**

Question 5 – 4 points

What is the disadvantage of the Ripple-Carry Adder?

1. Long propagation delay
2. Each stage requires additional hardware
3. Requires redundant hardware
4. Cannot support 2's complement integers

**ANS: (A) Long propagation delay, because of the carrying from low to high order stages.**

Question 6 – 4 points

Which of the following is not an output of the Arithmetic Logic Unit?

1. Result
2. Overflow
3. Zero
4. Bnegate

**ANS: (D) Bnegate, because the ALU outputs Result, Overflow, Zero, and Carry out.**

Question 7 – 26 points

Consider the binary numbers A = 1011 1000 and B = 0100 1010.

1. If A expresses an unsigned binary value, what base ten number does A represent?

**(1011 1000)­ = 1\*2^7 + 0 + 1\*2^5 + 1\*2^4 + 1\*2^3 + 0 + 0 + 0**

**= 128 + 32 + 16 + 8**

**= 184 <<<<<<<< ANS**

1. If A instead expresses a 2’s Complement value, what base ten number does A represent?

**The way to solve this is to work backwards from 2’s Complement.**

**2’s Compliment Steps:**

1. **Flip the bits (i.e. 1000 -> 0001)**
2. **Add (+1) (i.e. 0001 -> 0010)**

**// So the first thing to do would be to subtract 1 from A.**

**1011 1000 -> 1011 0111**

**// Then do a bit flip.**

**1011 0111 -> 0100 1000**

**// Now we have the value 0100 1000**

**= (-1) (2^6 + 2^3)**

**= (-1) (64 + 8)**

**= -72 <<<<<<< ANS**

1. If A and B are 2’s complement integers, determine A – B. State if Overflow occurs and explain why or why not.

A = 1011 1000

B = 0100 1010

**So really what happening here is that A – B is really A + (-B).**

**Thus, we have to perform 2’s Compliment on B, that is bit flip it and add (+1)**

**B = 0100 1010**

**// Bit Flip**

**0100 1010 -> 1011 0101**

**// Add (+1)**

**1011 0101 -> 1011 0110**

**Thus, (-B) = 1011 0110**

**And now we can perform the addition A + (-B):**

**0110 000**

**1011 1000**

**+ 1011 0110**

**0110 1110**

**\*\* But now there is a carry over number that is hanging off the end, therefore, THERE IS OVERFLOW!**

1. If A and B are 2’s complement integers, determine A \* B using Booth’s algorithm. Show all of your work to get full credit.

Multiplicand: -Multiplicand:

Multiplier:

Iteration Product Prev Step

Question 8 – 10 points

Consider a base ten value C = 113.3. What is the representation of C in single precision IEEE-754 format?

Question 9 – 10 points

Expand the following function to sum of minterms form and product of maxterms form. Clearly indicate your answers and how you derived them.

F(A, B, C) = B’C + AC’

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Question 10 – 30 points

Consider the design of an automatic outdoor light for a house. This light will be on if there is not enough light to see by otherwise or if motion is detected near the light. This requires two sensors: a motion sensor and a daylight sensor. The light can also be turned on and off by a light switch.

The basic operation of the light and the inputs and outputs of the controller are shown below.

The inputs and outputs are:  
 L = Light (1 = On, 0 = Off)  
 D = Daylight Sensor (1 = do not need light, 0 = dark, light is required)  
 M = Motion Detector (1 = Motion Detected, 0 = No Motion Detected)  
 S = Active switch (1 = light is on manually, 0 = light is off, rely on sensors)

The basic operation of the alarm can be described as:  
 If active switch is off, check daylight sensor and motion detector.  
 If daylight sensor is “dark” (W=0) or motion detector detects motion (M=1), turn on lights (L=1).

1. Complete the truth table below.

|  |  |  |  |
| --- | --- | --- | --- |
| Inputs | | | Output |
| S (Active switch) | M (Motion Detector) | D (Daylight Sensor) | L (Lights) |
|  |  |  |  |
|  |  |  |  |
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|  |  |  |  |

1. Give the most simplified Boolean expression for L, the output of the controller (Lights) using the following Karnaugh map.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SM  D | 00 | 01 | 11 | 10 |
| 0 |  |  |  |  |
| 1 |  |  |  |  |

A =

1. Implement the controller using discrete logic gates.