CSCI 232 FinalExam 2008

**Directions:** The usual…this exam is open book, open notes, closed neighbor, open mind. Read through the entire exam before starting to answer any question in order to plan how to most effectively use your time to maximize your score. Write legibly! If I can’t read it, it’s wrong. If you need more room for your answer, use the back of one of the test pages and indicate where I should look to find your answer. You have 150 minutes to complete the test. There are 170 points on this test, not counting 15 points of bonus questions. Good luck, and have fun!

1. **Combinational Logic:** (35 points total)
   1. (5 points) Draw logic diagrams for a circuit to compute odd parity of a 4 bit input. (Returns a 0 if the number of 1 bits in the input is odd, returns a 1 if the number of 1 bits in the input is even.)
   2. (5 points) Draw the logic diagram for a half adder which takes two inputs and returns a sum and a carry bit.
   3. (5 points) Use 4 full adders and some connecting logic, design a 4 bit adder-subtractor that adds when the M input line is high and subtracts when the M input line is low.
   4. (5 points) Use a Karnaugh map to simplify the Boolean function F(A,B,C,D)=Σ(0,1,2,6,8) with don’t-cares d(A,B,C,D)=Σ(4,9,10,11,14). Express it as a sum of products.
   5. (5 points) Use only NAND gates to implement the logic function **A’B’+B’C’+C’D’**.
   6. (5 points) Use the rules of logic to show that **x + xy = x**.
   7. (5 points) Use a truth table to verify that **x+yz = (x+y)(x+z)**.
2. **Sequential Logic:** (20 points total)
   1. (5 points) Use 4 D flip flops to implement a 4-bit shift register. This is a circuit that on each clock shifts each of the bits one place to the right, and shifts a 0 in on the left.
   2. (5 points) Using JK flip flops, implement a circuit to divide a clock signal by 4.
   3. (5 points) Using T flip-flops, design a 4 bit counter that counts up from 0 to 15.
   4. (5 points) How would you modify the counter in the previous problem to count down from 15 to 0?
3. **Data Representation** (3 points each, 51 points total)
4. Name two different codes used to represent characters inside a computer.
5. For 8-bit binary integers, give
   1. The 1’s complement representation of 42.
   2. The sign-magnitude representation of -42.
   3. The 2’s complement representation of -42.
   4. The 1’s complement representation of -42.
   5. The sign-magnitude representation of 42.
   6. The decimal number represented by the 1’s complement number 11100101.
   7. The decimal value represented by the 2’s complement number 10000000.
   8. The decimal value represented by the sign-magnitude number 01011010.
   9. Add the sign-magnitude numbers 10010101 and 10001111. Convert the sum to base 10.
   10. Add the 1’s complement numbers 11110101 and 11101101. Convert the sum to base 10.
   11. Add the 2’s complement numbers 01110001 and 10101111. Convert the sum to base 10.
6. What floating point value does the binary string 00000000000000000000000000000000 represent?
7. What is the approximate range of positive numbers that can be represented by 32 bit floating point values?
8. How many bits are used to store the mantissa of a nonzero normalized 32 bit floating point number?
9. How many bits are used to store the exponent of a nonzero normalized 32 bit floating point number?
10. What is the approximate range of 64 bit floating point numbers?
11. **General Architecture** (50 points total)
    1. (3 points) What are the two stages in performing a computer instruction?
    2. (3 points) What technology allows us to connect the output of multiple registers to a bus without burning out the registers?
    3. (3 points) Why do modern computers use registers instead of just using memory like some early computers did?
    4. (3 points) Why do modern computers use buses instead of doing everything with point to point wiring?
    5. (6 points) What are two different methods of building the control unit of a computer? What are the advantages and disadvantages of each method?
    6. (6 points) Explain how pipelining speeds up processor operations. What are the disadvantages of pipelining?
    7. (6 points) Use Booth’s algorithm to multiply the two 16 bit signed integers 0111 1110 0011 1111 and 0101 1100 0010 1011.
    8. (10 points) Draw a hypercube network connecting 8 processors. Be sure to show the ID number for each processor.
    9. (10 points) Describe the path taken by a message sent to processor 27 from processor 3 in a 32 bit hypercube. Be sure to list each processor that handles the message.

**7. Survey**

To help improve the computer architecture course, please fill out the following questionnaire. There are no incorrect answers—as long as you answer the questions at all, you will get 14 points! The answers are on a scale of 1 through 5 (unless otherwise indicated), with

1 = strongly disagree

2 = somewhat disagree

3 = neither agree nor disagree

4 = somewhat agree

5 = strongly agree.

**Labs:**

\_\_\_\_\_ 1. I found the labs to be interesting and enjoyable

\_\_\_\_\_ 2. I learned a lot by doing the labs

\_\_\_\_\_ 3. The labs consumed too much course time

\_\_\_\_\_ 4. The labs would have worked just as well without actually wiring them.

\_\_\_\_\_ 5. The labs were too low level (not enough computer design)

\_\_\_\_\_ 6. The labs became too complex too fast.

**Lectures:**

\_\_\_\_\_ 1. The lectures were where most learning occurred.

\_\_\_\_\_ 2. I preferred the lectures to the labs.

\_\_\_\_\_ 3. The lectures and labs complemented each other, each providing information that could not be taught by the other.

\_\_\_\_\_ 4. More time should have been spent in lecture with fewer labs.

**BONUSES:** Have fun with these with any time left over AFTER finishing the rest of the test! Each is worth 5 points.

**1. Sudoku:** The usual…use the digits 1-9 to fill in each square so that each row, column, or 3x3 box contains each of the digits 1,2,3,…,9 exactly once.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 3 |  |  | 8 | 2 | 1 |  |  |
|  |  | 1 | 6 | 9 |  | 5 |  | 8 |
|  |  | 8 |  |  |  |  | 9 |  |
| 7 |  |  |  |  | 5 |  |  |  |
|  | 6 | 5 |  | 4 |  | 9 | 3 |  |
|  |  |  | 8 |  |  |  |  | 5 |
|  | 2 |  |  |  |  | 4 |  |  |
| 4 |  | 9 |  | 5 | 6 | 8 |  |  |
|  |  | 7 | 4 | 2 |  |  | 5 |  |

**2. Cryptarithm:** The usual…each letter represents a digit, no two letters represent the same digit, and no digit is represented by more than one letter. Replace the letters with their corresponding numbers below to find the sum.

**CROSS**

**+ROADS**

**------**

**DANGER**

**4. Lady or the Tiger variant**

There are 2 doors, one with the king’s daughter behind it and the other with a tiger behind it. There is one guard standing by each door. Those two guards know which door is the daughter door and which is the tiger door. However, one of them always tells the truth and the other always tells a lie. There is no way you can identify which door is the daughter door or the tiger door. There is no way you can distinguish who is the one telling the truth.

A prisoner is put in the arena and can only ask one guard one question. Then he needs to choose a door to walk in. If he walks in the tiger door, then he will be eaten. If he walks in the daughter door, he marries the king’s daughter and gets half the kingdom.

He did choose the daughter door and lived happily ever after. What was the question he asked? How did he choose the door after he got the answer from one of the guards?