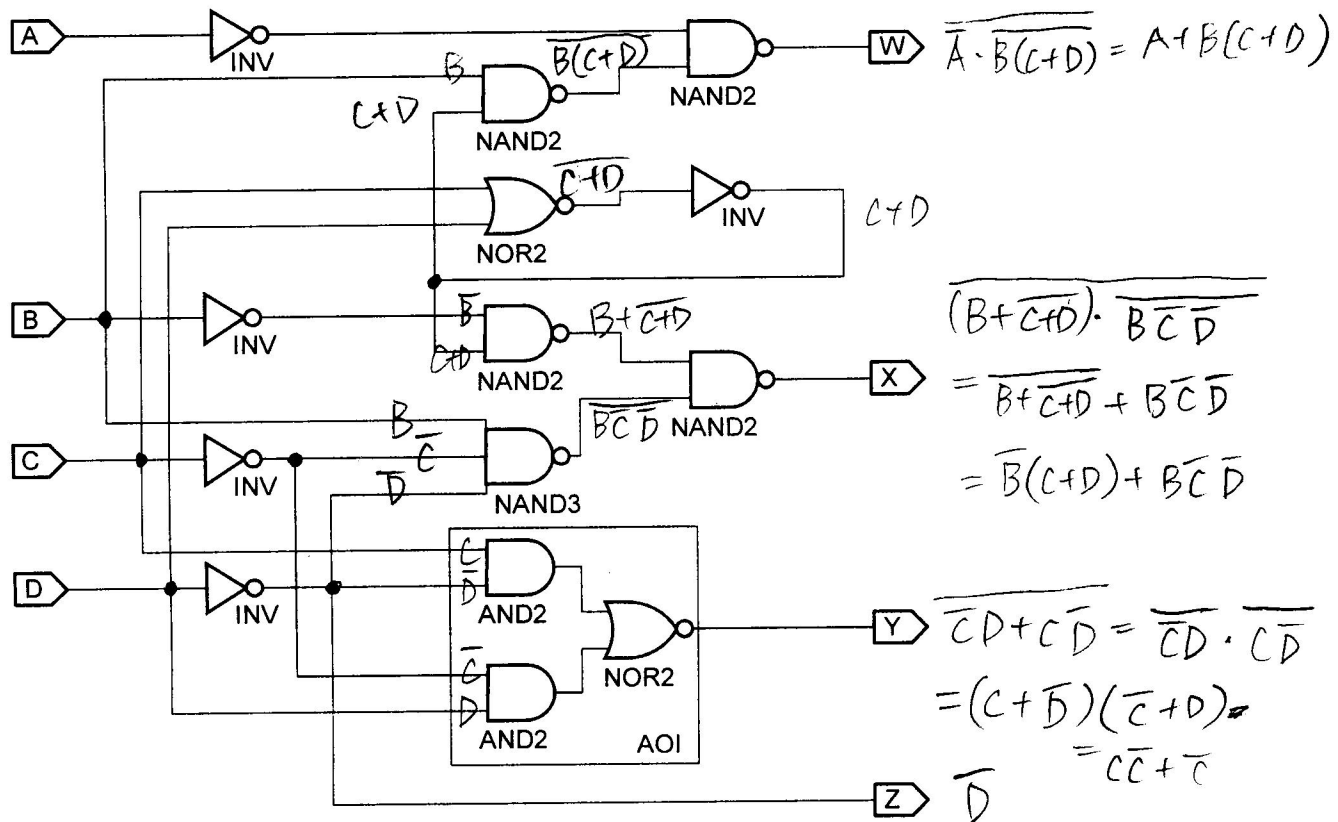# CS2102 Second Midterm Exam

10:10-11:50am, Thursday, November 26, 2009

Department of Computer Science

National Tsing Hua University

Note: Maximal Score = 110分

1. (15pts) Derive a truth table for the following circuit. What is its function?

$$\overline{\overline{A} \cdot \overline{B(C+D)}} = A + B(C+D)$$

$$\overline{(B+\overline{C+D}) \cdot \overline{BC\overline{D}}}$$
$$= \overline{B+\overline{C+D}} + BC\overline{D}$$
$$= \overline{B}(C+D) + BC\overline{D}$$

$$\overline{\overline{CD+C\overline{D}}} = \overline{CD} \cdot \overline{C\overline{D}}$$
$$= (\overline{C}+\overline{D})(\overline{C}+D)$$
$$= \overline{C}\overline{C} + \overline{C}$$

2. (15 pts) Given <u>two 4</u>-to-2 priority encoders. Design a 8-to-3 priority encoder by adding to them some circuits. Name the encoder's valid flag V, outputs X_2, X_1, X_0 and inputs A_7, A_6, ..., A_0 with A_7 having the highest priority. For example, when A = 0010 0110, X should equals 101 and V = 1, while when A = 0000 0000, V should equals 0.   l

3. (10 pts) Represent -149.375_{10} in 14-bit   (9 bits before and 5 bits after radix point)
    A. Signed-magnitude Binary format
    B. One's Complement Binary Format
    C. Two's Complement Binary Format

4. (10pts) Given a 8-to-1 multiplexer. Design a 4-input-1-output combinational function that output 1 when the input has equal number of 1s and 0s, and output 0 otherwise.
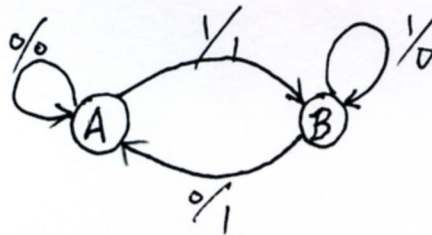
$1 \mid 0$

5. (20 pts) Analyze the following circuit:
   A. Derive the state table
   B. Derive the state transition diagram
   C. Simplify your diagram by merging equivalent states if possible.
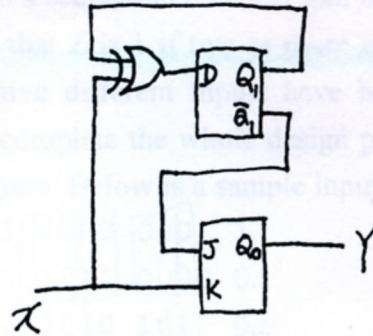
Y 0 1 1 1 1 0 1 1 1 1 0 0 0
X 1 0 0 0 1 0 0 0 0 1 0 1

6. (15 pts) Design a circuit implementing the following state transition diagram. Use one positive edge-triggered D-type flip-flop.

7. (10 pts) Given a D-type flip-flop. Add some circuit to it to make a JK flip-flop.

8. (15 pts) Design a string recognizer with input X and output Y for the pattern 11011. For example,

```
X = 1001 1011 0110 1111 0110 0...
Y = 0000 0001 0010 0100 0010 0...
```

Just draw a **Mealy** style state transition diagram. Note that a Mealy machine's output depends on both state and input.

9. (15 pts) Design a sequential machine that has two binary inputs X and Y, and one output Z such that Z is 1 if two or more consecutive identical inputs, or two or more consecutive different inputs have been observed, and 0 otherwise. You don't have to complete the whole design process. Just draw a **Moore** style state transition diagram. Below is a sample input and output sequences of the machine.

```
X = 0111 1000 0001 1...
Y = 1100 1011 0000 0...
Z = 0000 1010 1011 0...
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