Department of Computer and Information Science
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# Digital Systems

Midterm Exam 04/21/2003

1. (10%) Simplify the following expression in sum-of-products form. Implement the simplified circuit using NAND gates.

$$\overline{A}B + \overline{B}C + \overline{A}\,\overline{B}\,\overline{C}$$

2. (8%) Find all prime implicants and essential prime implicants of

$$F(W,X,Y,Z) = \sum m(0,1,4,9,11,12,13,15)$$

3. (8%) Use two transmission gates and some inverters to implement

| $X$ | $Y$ | $F$ |
|---|---|---|
| 0 | 0 | open |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

4. (14%) Simplify the following Boolean function $F$ together with the don't care condition $d$ in (i) sum-of-products form, (ii) product-of-sums form:

$$F(W,X,Y,Z) = \sum m(0,1,6,15),$$

$$d(W,X,Y,Z) = \sum m(2,5,7,9,13,14)$$

5. (8%) Consider the addition of two binary numbers 0101 and 0110. Based on the concept of *carry lookahead*, find the value of $P_{0-3}$ and $G_{0-3}$.

6. (16%) Consider the logic diagram shown below.
(a) Obtain the truth table for output $F$. (Hint: Consider $F$ for $A = 0$ and $A = 1$ separately.)
(b) Give a change in inputs which will result in the longest delay for output $F$ to change.

7. (8%) Design a combinational circuit that compares two 2-bit unsigned numbers *A* and *B* to see whether *B* is greater than *A*, using an 8-to-1 line multiplexer.

8. (10%) Perform the arithmetic operations (+13) + (-7) and (-13) - (+7) in binary using 5-bit signed-2's complement representation for negative numbers. Determine if there is an overflow for each of the operations.

9. (8%) What is the main difference between
   (a) a *D* latch and a *D* flip-flop,
   (b) a master-slave *JK* flip-flop and an edge-triggered *JK* flip-flop.

10. (10%) Obtain the characteristic table of the following edge-triggered *JK* flip-flop.