King Mongkut's University of Technology Thonburi
Midterm Examination of First Semester, Academic Year 2008

COURSE CPE 220 Digital ~~Circuit~~ System Design — **Computer Engineering Department, 2nd Yr.**
Friday 25 July — **13.00-16.00h.**

Instructions

1. This examination contains 5 problems, 8 pages (including this cover page).
2. The answers must be written in these examination sheets.
3. Students are allowed to use paper-based dictionaries.
4. Students are **not** allowed to use calculators.
5. **No** books, notes, or any other documents can be taken into the examination room.

Students must raise their hand to inform to the proctor upon their completion of the examination, to ask for permission to leave the examination room.
Students must not take the examination and the answers out of the examination room.

Students will be punished if they violate any examination rules. The highest punishment is dismissal.

This examination is designed by

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This examination is approved by the department of computer engineering.

Student Name _____ Student ID _____ Seat No._____

Exam Problem	Total Points	Obtained Points
Problem 1	10	
Problem 2	20	
Problem 3	14	
Problem 4	29	
Problem 5	27	
Sum	100	

Problem 1:

Determine each of the following statements, and answer True or False. (10 points)

1.1 CPLD has a FAN-IN limitation; each logic gate can have a maximum fan-in of two.

1.2 FPGA chips cost more than any other chip types because they are application-specific designed.

1.3 The size of transistor gate length has been decreased in the past few years.

1.4 PMOS transister has its substrate connected to VDD, and NMOS transister has its substate connected to GND.

1.5 The function G(X, Y, Z) is valid where

$G(X, Y, Z) = m_1 + m_2 + m_3 + m_4 + m_5 + m_6 = X'Y' + XZ' + Y'Z$

Problem 2: Given $F(A,B,C) = \overline{A}\,\overline{B}\,C + \overline{A}\,B + B\overline{C} + A\overline{C}$ (20 points)

2.1 Find the corresponding minterms for the function F (3 points)

2.2 Find the corresponding maxterms for the function F (3 points)

2.3 Find the minimum sum-of-product expression for the function F using algebraic manipulation (4 points)

2.4 Find the minimum sum-of-product expression for the function F using K-Map (3 points)

2.5) Find the minimum product-of-sum expression for the function F (3 points)

2.6) Draw a timing diagram for the function F considering all possible states of inputs and output (4 points)

Problem 3: Given two functions F and G, where

$$F(A,B,C)=\overline{A}\,\overline{B}+\overline{A}\,\overline{C}+C$$

$$G(A,B,C)=AB+BC+ABC \quad \text{(14 points, 7 points each)}$$

The input variables are available only in TRUE forms.

3.1 Design a CMOS circuit for the function F using minimum number of transistors.

3.2 Design a CMOS circuit for the function G using minimum number of transistors.

Problem 4:

4.1: Given two functions F and G

$$F(A, B, C, D) = \sum m\,(0, 2, 4, 6, 7, 9) + d(10, 11, 15)$$

$$G(A, B, C, D) = \sum m\,(2, 4, 9, 10, 15) + d(0, 6, 7, 13, 14)$$

The input variables are available in both complemented and true form.

4.1.1) Implement functions F and G separately. Find cost of the circuit implementation? (7 points)

4.1.2) Redesign the circuit to have minimum cost using logic gates AND, OR, NOT. What is the cost of this new circuit? (8 points)

4.2 Given $F(X_1, X_2, X_3, X_4) = \prod M\ (0, 3, 4, 7, 9, 10, 13, 14)$

Derive a minimum-cost circuit that implement function F.

The circuit has a maximum fan-in of two.

The input variables are available only in the true form: X_1 , X_2 , X_3, X_4 (14 points)

Problem 5:

5.1 Complete values in the table for the corresponding unsigned numbers. (12 points)

Decimal	Binary	Hexadecimal
21.5		

Binary	Decimal	Octal
101110.01		

Octal	Decimal	Hexadecimal
77		

Hexadecimal	Binary	Octal
10C.A		

5.2 Perform the following operations where each number has 6 bits. Show your answers by converting to decimal sign-and-magnitude representation.

5.2.1) The numbers are given in sign-magnitude representation. (5 points)

$$\begin{array}{r} 010110 \\ + \\ \underline{101101} \end{array}$$

5.2.2) The numbers are given in the 1's complement representation. (5 points)

$$\begin{array}{r} 001101 \\ + \\ \underline{110110} \end{array}$$

5.2.3) The numbers are given in the 2's complement form. (5 points)

$$\begin{array}{r} 101100 \\ + \\ \underline{111010} \end{array}$$