King Mongkut's University of Technology Thonburi
Midterm Exam of Second Semester, Academic Year 2016

CPE 223 Digital System Design

CPE(Inter.) Students

Thursday 23 February 2017

13.00-16.00

Instructions
1. This examination contains 11 problems, 10 pages (including this cover page), The total score is 30 points.
2. The answers must be written in the space provided.
3. **Allow** a **calculator.**
4. **Books**, **notes**, and **dictionary** are **NOT** allowed.

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 prepared by

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This examination paper is approved by Computer Engineering Department.

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Head of Curriculum

Problem	1	2	3	4	5	6	7	8	9	10	11	Total
Points	4	2	2	2	2	2	2	4	2	5	3	30
Earned Points												

Student Name: _____ I.D.: _____

1. Design and sketch a two-bit full adder circuit using 2-input NAND gates only,   (4 points)

$$x_1 x_0 \qquad y_1 y_0$$

$$\downarrow 2 \qquad \downarrow 2$$

Cout ← Full adder ← Cin

$$\downarrow 2$$

$$s_1 s_0$$
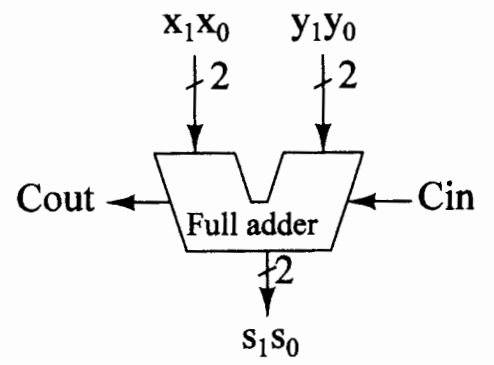
2. Convert the following numbers to binary numbers   (2 points)

a) $(21.375)_{10}$ b) $(7007.7)_8$ c) $(2323.33)_4$ d) $(FA.AF)_{16}$

3. Perform the following arithmetic operations using 10-bit 2's complement system. Also, determine if an overflow occurs.   (2 points)

a) $1110010010 - 0101111001$ b) $0111010101 + 0111110010$

4. Simplify the following Boolean expressions to a minimal number of literals   (2 points)

   a) $(w'x + y'z)(wz' + x'y')$ b) $(A + B)(C + D)(A' + B + D)$

5. Given $F(A,B,C,D) = \sum(1,9,11,14,15)$. Determine $F'(A,B,C,D)$ and minimize $F'(A,B,C,D)$.

                                                              (2 points)

4

6. Simplify the following Boolean function F, together with the don't-care conditions d, and then express the simplified function in sum-of-minterms form: (2 points)

$F(A, B, C, D) = \sum(2, 4, 7, 10,12), \quad d(A, B, C, D) = \sum(1, 5, 11)$

7. Find all the prime implicants for the following Boolean function, and determine which are essential:

$F(A, B, C, D) = \sum(0, 1, 3, 7, 8, 9, 10, 13, 15)$ (2 points)

8. Minimize the following functions together and implement the circuit (only one circuit) that produces three outputs, F1, F2 and F3.

$$F1(A,B,C,D) = \sum(1,3,4,6,8,9,10,11,12,14)$$
$$F2(A,B,C,D) = \sum(0,1,2,3,8,9,10,11,12,14)$$
$$F3(A,B,C,D) = \sum(1,3,4,5,6,7,8,10,12,14)$$

Draw the circuit using NAND gates only. How many ICs used? The smaller the number of ICs, the better score.
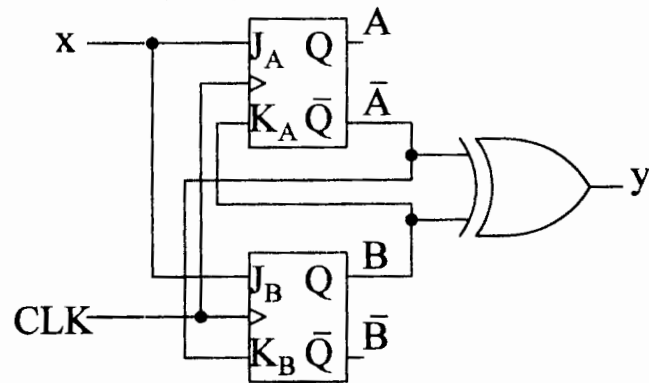
(4 points)

9. Implement the following Boolean function with an 8-to-1 multiplexer.

$$F(A, B, C) = \sum(1, 2, 5, 7)$$

(2 points)

10. A sequential circuit has two JK flip-flops A and B and one input x and one output y.
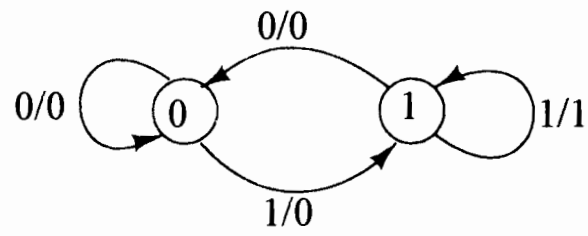

(a) Determine flip-flop input equations and derive the state table of the circuit.
(b) Draw the state diagram of the circuit.   (5 points)

Present State	Input	Next State	Output	Flip-flop inputs
A B	x	A B	y	J_A K_A J_B K_B

11. From the state diagram below, derive the state table and design the sequential circuit using D-flip-flop. Is this circuit a Moore or Mealy machine? (3 points)

Supplemental

V_{CC}

2-input NAND
7400

V_{CC}

2-input NOR
7402

V_{CC}

Inverters
7404

V_{CC}

2-input AND
7408

V_{CC}

3-input NAND
7410

V_{CC}

4-input NAND
7420

V_{CC}

2-input OR
7432

V_{CC}

2-input XOR
7486

10