Seat No.:_____

King Mongkut's University of Technology Thonburi
Midterm Exam of Second Semester, Academic Year 2015

CPE 223 Digital System Design — CPE(Inter.) Students

Tueday 23 February 2016 — 13.00-16.00

Instructions

1. This examination contains 10 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

Asst. Prof. Sanan Srakaew

Tel. 0-2470-9083

This examination paper is approved by Computer Engineering Department.

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

Student Name: _____ I.D.: _____

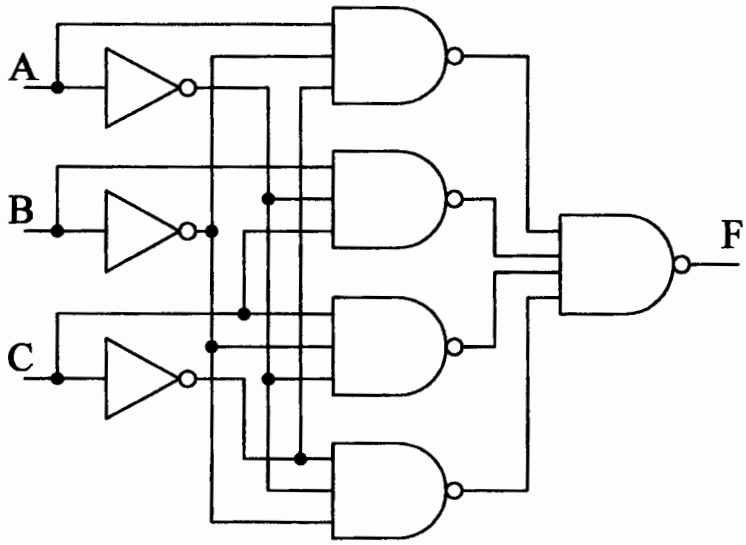
1. Convert the following numbers to binary numbers (2 points)
   a) $(DA.DA)_{16}$ b) $(7007.2)_8$ c) $(3210.01)_4$ d) $(12345.4375)_{10}$

2. Perform the following arithmetic operations using 10-bit 2's complement system. Also, determine if an overflow occurs. (2 points)
   a) 1010010001 – 0100101011 b) 0111010101 + 0110010010

3. Simplify the following Boolean expressions to a minimal number of literals (2 points)
   a) (A′B + C′D)(AD′ + B′C′) b) A′B′C′D′ + A′B′CD′ + AB′D′+ BC′D′ + BCD′

4. Given F(A,B,C,D) = ∑(1,9,11,14,15). Determine F′(A,B,C,D) and minimize F′(A,B,C,D). (2 points)

5. From the circuit below:



a) Determine the Boolean function.
b) Implement it using a decoder.
c) Minimize the Boolean function and implement a new circuit from the minimized function using NAND gates only.

(3 points)

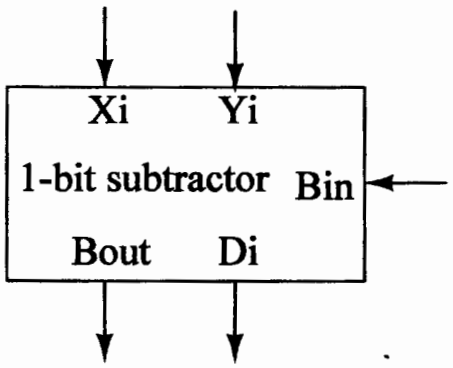
6. Minimize the following functions together and implement the circuit (only one circuit) that produces three outputs, F1, F2 and F3.

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

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

(4 points)

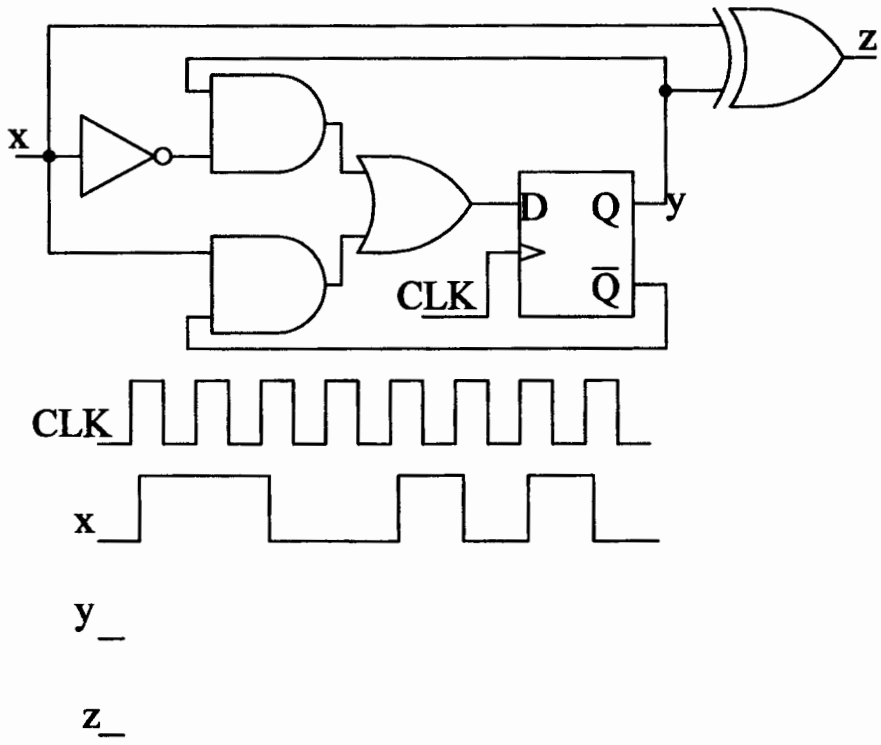
7. Design and implement a 4-bit subtractor using four 1-bit subtractors. **Hints**: First draw a truth table of 1-bit subtractor that takes two inputs Xi and Yi and Borrow-in (Bin) and the 2-bit result is in Difference(Di) and Borrow-out (Bout). Then implement a 1-bit subtractor using AND, OR, XOR, inverter gates. (4 points)



{Bout, Di} = Xi – Yi – Bin

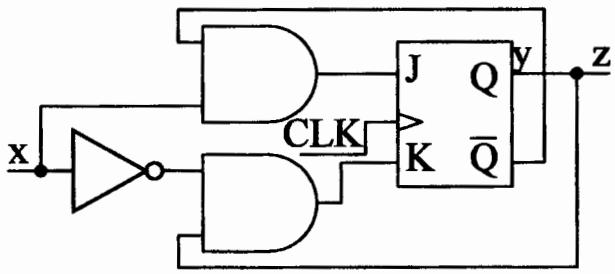
8. Sketch the circuit that has four input buttons(PB1-PB4) and two output LEDs (Red and Green). The red LED is turned on when the number of buttons pushed are even(for example no button, or two buttons, or four buttons are pushed) The green LED is turned on when the number of buttons pushed are odd(for example one button, or three buttons are pushed). Also, provide a truth table, determine the Boolean functions, and then minimize the functions.
Hint: Buttons and LEDs must be connected with resistors and 5V power supply. (3 points)

9. Determine the state transition table, state diagram, and timing diagram of the following circuit. (4 points)

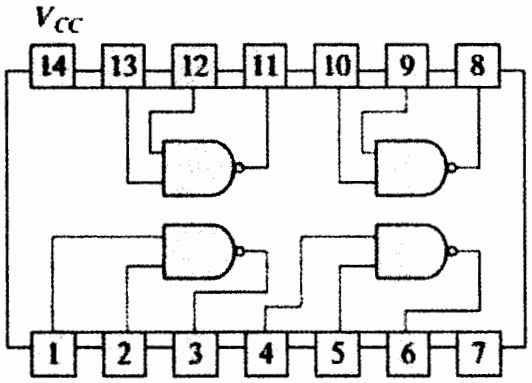


Present State	Input	Next State	Output
y	x	y	z

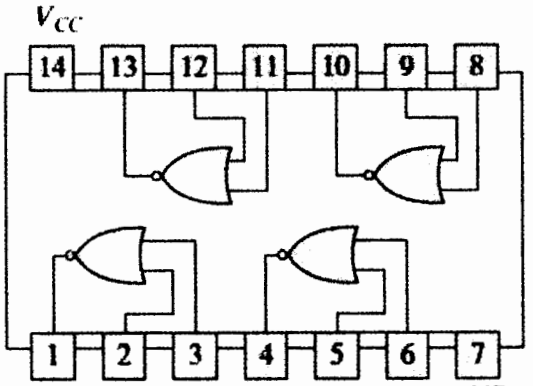
10. Determine the state transition table and state diagram of the following circuit. Is this circuit a Moore or Mealy machine? (4 points)



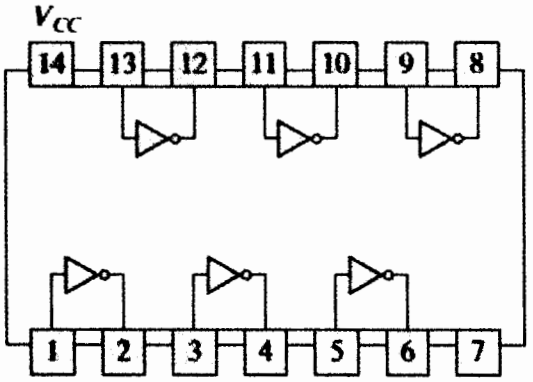
Supplemental



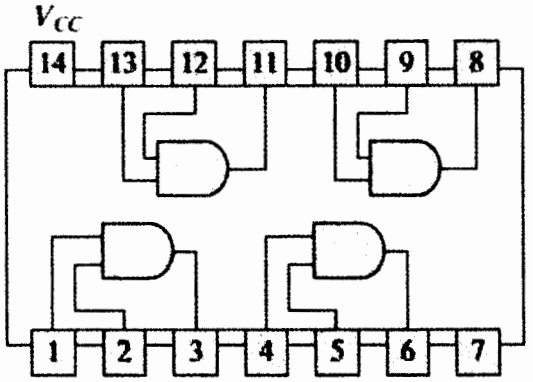
2-input NAND
7400



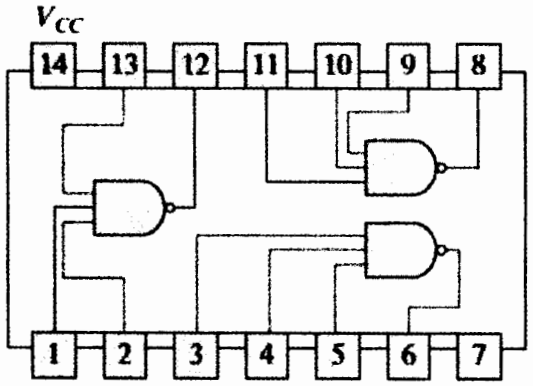
2-input NOR
7402



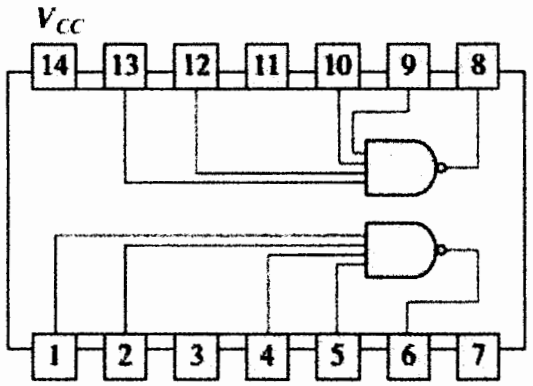
Inverters
7404



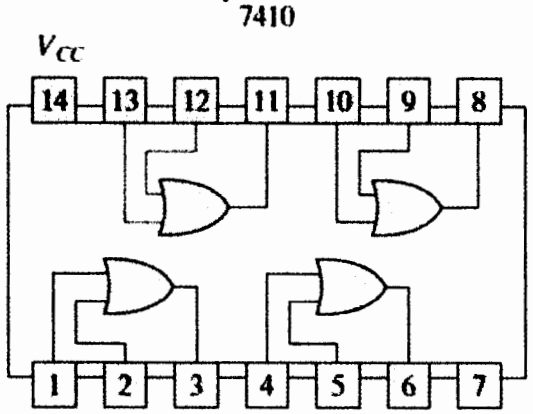
2-input AND
7408



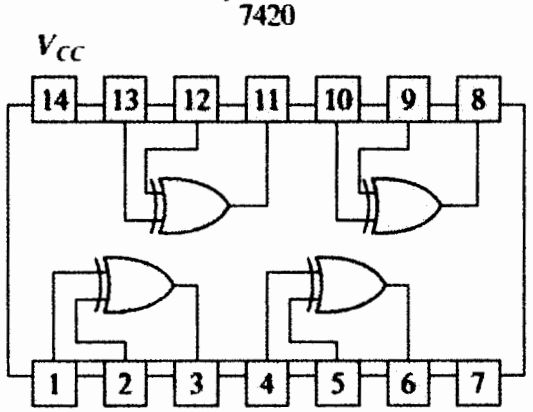
3-input NAND
7410



4-input NAND
7420



2-input OR
7432



2-input XOR
7486