Sirindhorn International Institute of Technology

Thammasat University at Rangsit

School of Information, Computer and Communication Technology

ECS371: Sample Problems for Midterm Examination

COURSE : ECS371 (Digital Circuits)
DATE : July 30, 2009
SEMESTER : 1/2009
INSTRUCTOR: Dr. Prapun Suksompong
TIME : 13:30-16:30
PLACE : BKD 3207 and BKD 3216

Name		ID	
Section		Seat	

Instructions:

1. Including this cover page, this sample exam has 8 pages.
2. **Read the questions carefully**.
3. Write your **first name and ID** on each page of your examination paper.
4. Write all your work in the space provided. You may not get full credit even when your answer is right without all of your work written down.
5. Closed book. Closed notes. No calculator.
6. Allocate your time wisely.
7. Do not cheat. The use of communication devices including mobile phones is prohibited in the examination room.
8. Your scores will depend strongly on the clarity and completeness of your solutions.
9. Do not panic.

Note: The actual exam will (most likely) be shorter.

Part A: TRUE/FALSE.

Write 'T' if the statement is true and 'F' if the statement is false. If the statement is false, explain why. Put your answers/explanations in the table given below.

1. When the inputs to a 2–input AND gate are both LOW, the output is LOW.
2.
3.

Question	T/F	Explanation
1		
2		
3		

Part B: MULTIPLE CHOICE.

Choose the one alternative that best completes the statement or answers the question. Put your answers in the table given below.

4. A multiplexer with four select, or address, lines can select one of ________ inputs.
   a. 7
   b. 3
   c. 15
   d. 16
5.
6.

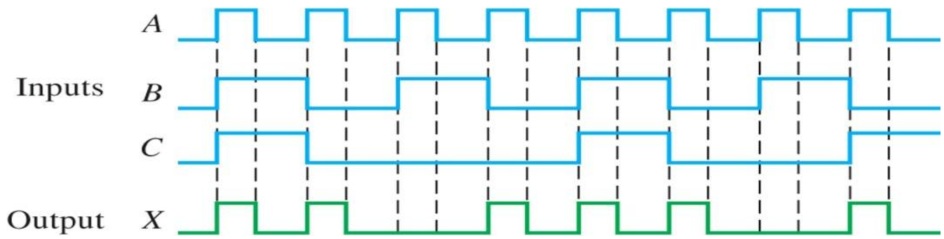
Question	Answer
4	
5	
6	

Part C

7. Convert the following binary numbers to decimal:
    a. 10000
    b. 10001
    c. 10101
8. What is the largest decimal number that can be represented in binary with 8 bits?
9. How many bits are required to represent the following decimal numbers?
    a. 100
    b. 300
    c. 600
10. Determine the weight of the 5 in the following decimal numbers:
    a. 12345
    b. 54321
    c. 23541
11. Convert each decimal number to binary using repeated division by 2:
    a. 40
    b. 100
12. Determine the 2's complement of the following binary numbers
    a. 0001
    b. 1000
    c. 11001
13. Express each decimal number as an 8-bit number in the 2's complement form:
    a. +20
    b. -33
14. Determine the decimal value of each signed binary number in the 2's complement form:
    a. 11000000
    b. 00011101
15. Describe the sign extension process for 2's complement signed numbers. Then, give two examples.
16. For 7 bits 2's complement signed numbers, the range is ________ to _______
17. Give at least two MAIN advantages of using 2's complement signed numbers.
18. Using Boolean algebra, simplify the following expressions into a minimal sum:
    a. $X = AB + \overline{A}C + BC + A\overline{B}C$
19. Represent the number "-9" using eight bits in each of the representation below:
    a. "-9" in sign-magnitude representation: ______________
    b. "-9" in 1's complement representation: ______________
    c. "-9" in 2's complement representation: ______________
20. Construct a 4-input AND gate using 2-input AND gates. (Other gates can not be used!) You may use at most three 2-input AND gates.
21. Construct a 4-input NAND gate using 2-input NAND gate. (Other gates can not be used!) You may use at most five 2-input NAND gates.
22. Develop a truth table for each of the following expressions.
    a. $X = A + BC + CD$

b.

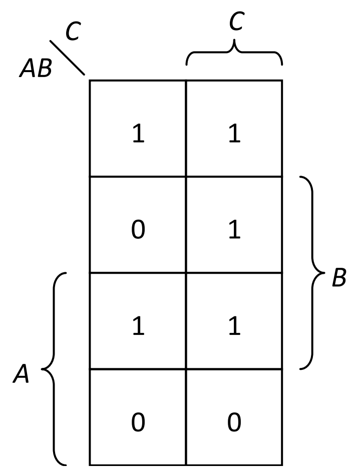
23. For the input waveforms in the figure below, what logic circuit will generate the output waveform shown?



a. Determine the canonical sum representation of the circuit.
b. Implement the circuit using AND-OR configuration.
c. Implement the circuit using NAND gates.

24. Find ALL prime implicants in the following Karnaugh maps.

a.



b.

25. Use a Karnaugh map to reduce each expression to a minimum SOP form. For each term in your minimum SOP expression, indicate clearly which group on the K-map corresponds to that term.

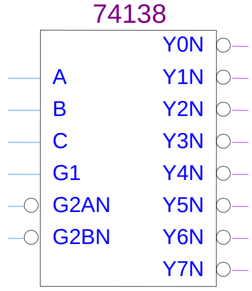
a. $A\cdot\overline{C}\cdot\overline{D}+A\cdot B\cdot\overline{C}+A\cdot\overline{B}\cdot D+\overline{A}\cdot\overline{B}\cdot\overline{C}\cdot D+A\cdot B\cdot C\cdot\overline{D}$

b.

26. Let $X = AB + \overline{A}C + BC$

a. Develop a truth table for *X*
b. Determine the canonical sum that represents *X.*
c. Determine the minterm list that represents *X.*
d. Determine the maxterm list that represents *X.*
e. Determine the canonical product that represents *X.*
f. Determine the *K*-map that represents *X.*
g. Find ALL the prime implicants in the K-map.
h. Determine the minimal sum for *X.* For each term in your minimal sum, indicate clearly which group on the K-map corresponds to that term.
i. Using Boolean algebra, simplify $AB + \overline{A}C + BC$ into the minimal sum that you got in the previous question.
j. Implement the minimal sum using AND-OR circuit.
k. Implement the minimal sum using NAND gates.
l. Implement the minimal sum using one 3:8 decoder and one OR gate.
m. Implement the minimal sum using one 74x138 and one NAND gate.

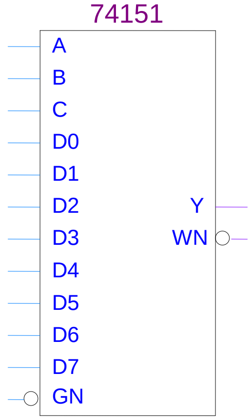
74138



3:8 DECODER

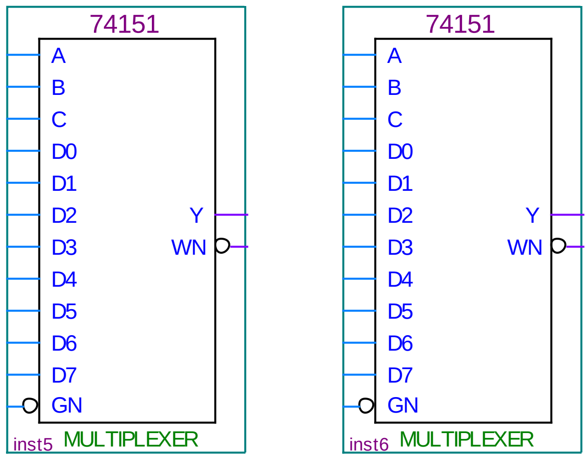
n. Implement the minimal sum using one 8:1 MUX.
o. Implement the minimal sum using one 74x151.

74151



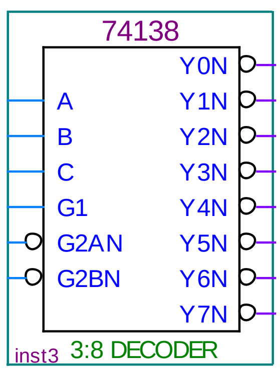
MULTIPLEXER

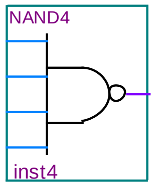
27. In class, we implemented a full-adder using a 3:8 decoder and two OR gates. For this question, implement a full-adder using two 74x151s.



28. Implement the logic function specified in the table below by using only a 74x138 and a NAND gate.

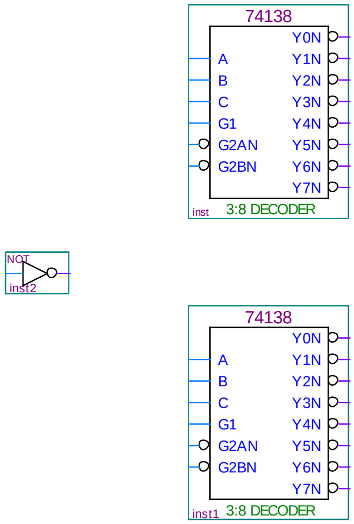
Input			Output
X	Y	Z	W
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0





Your score depends strongly on your explanation of your answer. Zero score may be given even for a correct answer if the explanation is incomplete.

29. Construct a 4:16 decoder with an active-HIGH enable (EN) and active-LOW outputs from two 74x138 decoders and one NOT gate. Label the inputs of the 4:16 decoder by I_3, I_2, I_1, I_0 where I_3 is the MSB. Label the outputs of the 4:16 decoder by O_{15}_L, O_{14}_L, O_{13}_L, O_{12}_L, ..., O_1_L, O_0_L.



Again, your score depends strongly on your explanation of your answer. Zero score may be given even for a correct answer if the explanation is incomplete.