CS2100 Computer Organization

AY2023/24 Semester I

Assignment 3

(Deadline: 6 November 2023, Monday, 1pm)

Instructions

1. There are FOUR (4) questions in this assignment, totaling THIRTY-SEVEN (37) marks. Please do all parts of every question. Marks are indicated against each part.

2. An additional 3 marks is awarded for putting in your name, student ID and tutorial group number in your answers and for submitting in PDF format with the correct naming convention (see below). Thus, the total will be FORTY (40) marks. If you fail to do any of these, you will lose the 3 marks.

3. This assignment is due on **Monday, 6 November 2023, 1 pm.** You will be given until 1:15 pm to submit, **after which no submission will be accepted and you will receive ZERO for this assignment, regardless of how hard you've worked on it.**

4. **Plan to submit at least 2 hours early (i.e., by 11 am on 6 November)** in case there are technical issues with submission. If, by 1 pm on 6 November you are unable to submit due to technical reasons, please email your answers to Aaron at tantc@comp.nus.edu.sg before 1:15 pm. **No submission over email will be accepted after 1:15 pm.**

5. It is your responsibility to check that you have submit the correct file, and that it is complete, i.e., no missing pages.

6. Complete your answers on the provided **CS2100Assg3AnsBk.docx** file. Save it as AxxxxxxxY.pdf (where AxxxxxxxY is your Student ID) before submitting.

7. Unlike assignments 1 and 2, **you do NOT need to zip your file this time**. Just submit your pdf file. Only one file needs to be submitted. We will grade your last submitted file.

8. You should do these assignments on your own. Do not discuss the assignment questions with others.

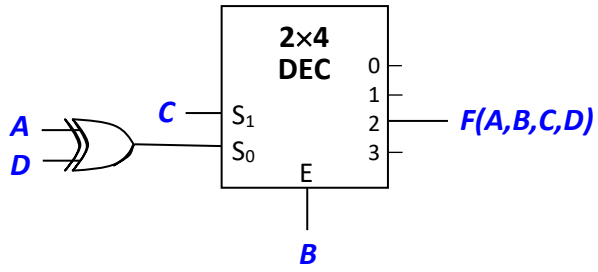
9. Please use the QnA forums for clarifications.

Note that unless otherwise stated, complemented literals are not available.

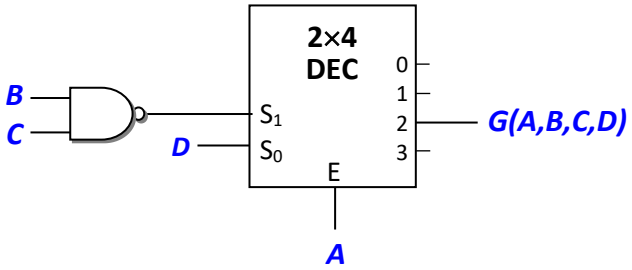
Question 1. (6 MARKS)

For each of the following implementations using 2x4 decoders with one-enable, write out the function in **Σm notation** (sum-of-minterms). Pay attention to the order of the variables in the function.

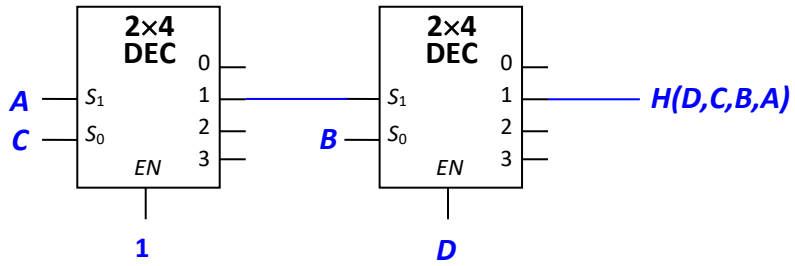
(a) (2 marks)



(b) (2 marks)



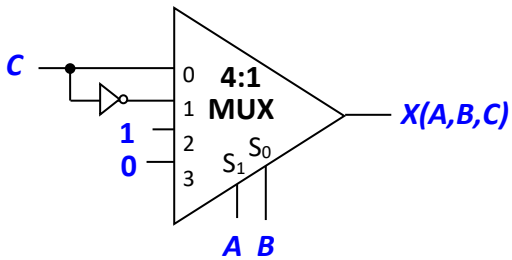
(c) (2 marks)



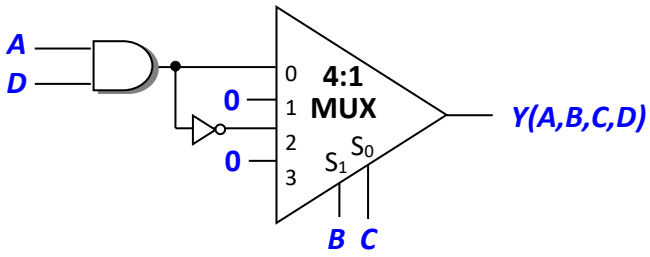
Question 2. (6 MARKS)

For each of the following implementations using 4:1 and 2:1 multiplexers, write out the function in **ΠM notation** (product-of-maxterms). Pay attention to the order of the variables in the function.

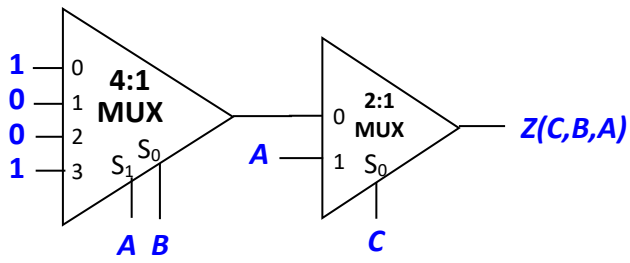
(a) (2 marks)



(b) (2 marks)

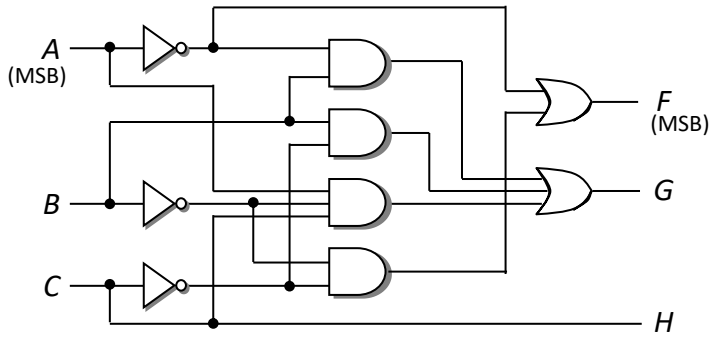


(c) (2 marks)



Question 3. (7 MARKS)

The logic circuit below is a code converter.



(a) Write the simplified SOP expressions for *F*, *G* and *H*. (3 marks)

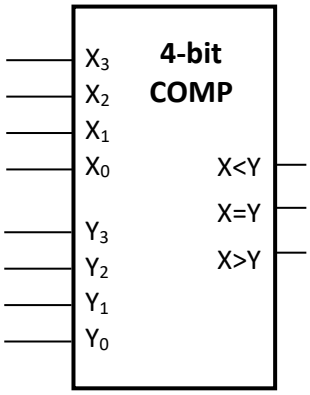
(b) Given this statement that describes that function of the above circuit, (2 marks)

"The circuit converts a 3-bit _____ to 3-bit _____."

fill in the blanks by choosing among the following choices:

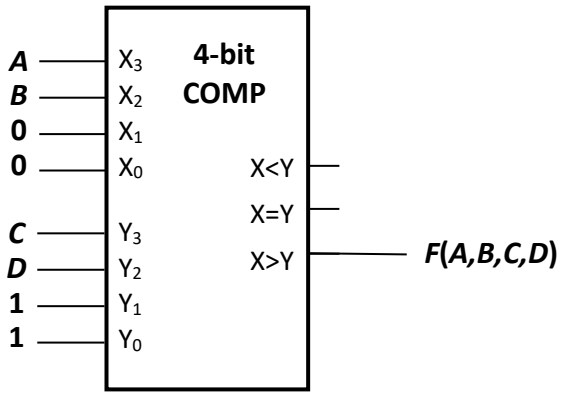
- 1's complement number
- 2's complement number
- excess 4 code
- excess 3 code
- sign-and-magnitude number

(c) Using a single 4-bit magnitude comparator as shown below, implement the function *F* of the above circuit. You are <u>not</u> to use any other devices or logic gates. (2 marks)



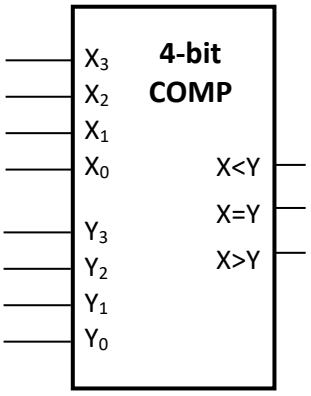
Question 4. (7 MARKS)

(a) Given the following 4-bit magnitude comparator and inputs, what is the simplified SOP expression of *F(A,B,C,D)*? (2 marks)



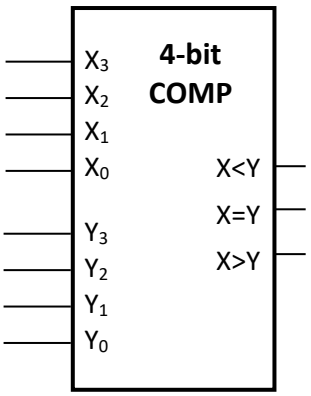
(b) Implement the following function using a single 4-bit magnitude comparator and at most one additional logic gate. (Logic gates are inverters (NOT), AND, OR, NAND, NOR, XOR, and XNOR gates. Apart from inverters, the rest are 2-input logic gates.)

$G(A,B,C,D) = \Pi M(5,13)$ (2 marks)



(c) Implement the following function using a single 4-bit magnitude comparator without any additional logic gate.

$H(A,B,C,D) = \Sigma m(1,2,3,8,9,10,11)$ (3 marks)



Question 5. (5 MARKS)

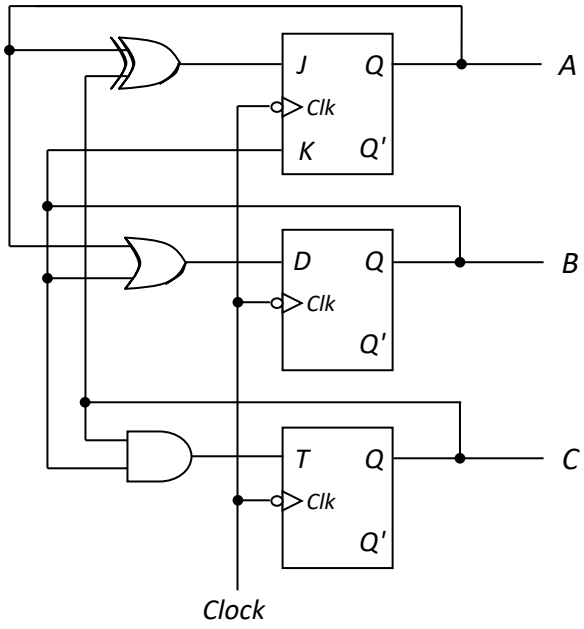
Below is a partial function table of an **8-to-3 priority encoder**. It consists of 8 inputs (A_7 to A_0) and 3 outputs (F_2 to F_0). A_i has higher priority than A_j if $i>j$. The only invalid input combination occurs when all inputs are zero. 'X' represents don't-care.

A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	F_2	F_1	F_0
0	0	0	0	0	0	0	0	X	X	X
1	X	X	X	X	X	X	X	1	1	1
0	1	X	X	X	X	X	X	1	1	0
0	0	1	X	X	X	X	X	1	0	1
:								:		
0	0	0	0	0	0	1	X	0	0	1
0	0	0	0	0	0	0	1	0	0	0

Write out the simplified SOP expressions for F_2, F_1 and F_0.

Question 6. (6 MARKS)

Study the sequential circuit below with state *ABC*.



You may write your answers in decimal, for example, state 5 for state 101_2.

(a) If the initial state is 1 (or 001_2), what state is the circuit in after 2 clock cycles? (2 marks)

(b) If the initial state is 3 (or 011_2), what state is the circuit in after 2 clock cycles? (2 marks)

(c) Identify all the sink states in this circuit. (2 marks)

=== END OF PAPER ===