NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING

MID-TERM TEST
AY2015/6 Semester 1

CS2100 — COMPUTER ORGANISATION

6 October 2015 Time Allowed: **1 hour 30 minutes**

INSTRUCTIONS

1. This question paper contains **ELEVEN (11)** questions (excluding the bonus question) and comprises **EIGHT (8)** printed pages.
2. The last two pages are for your rough work. They contain blank truth tables, K-maps and state table for your use.
3. An **Answer Sheet**, comprising **TWO (2)** printed page, is provided for you.
4. Write your **Name**, **Matriculation Number** and **Tutorial Group Number** on the Answer Sheet with a **PEN**.
5. You may write your answers in pencil (at least 2B).
6. Answer **ALL** questions within the space provided on the Answer Sheet.
7. Submit only the Answer Sheet at the end of the test. You may keep the question paper.
8. Maximum score is **40 marks**.
9. This is a **CLOSED BOOK** test. However, an A4 single-sheet double-sided handwritten reference sheet is allowed.
10. Calculators and computing devices such as laptops and PDAs are not allowed.

——— END OF INSTRUCTIONS ———

Bonus question:

0. [This is the bonus question which is worth 1 mark. The mark of this question will only be added if the total mark scored is less than 40.]

   Which of the following characters came to the CS2100 lecture on 7 September 2015?

   A. 

   B. 

   C. 

Note the following symbols and acronyms used in this paper:

- $\oplus$: exclusive-OR (XOR)
- $\odot$: exclusive-NOR (XNOR)
- **SOP**: Sum-of-Products
- **POS**: Product-of-Sums

Questions 1 – 5: Each multiple-choice-question has only <u>one</u> correct answer. Write your answers in the boxes on the **Answer Sheet**. Two marks are awarded for each correct answer and no penalty for wrong answer.

1. Which of the following weighted decimal codes is <u>not</u> self-complementing?

   A. 2421 code
   B. 3132 code
   C. 5211 code
   D. 4421 code
   E. None of the above.

2. Given the following hexadecimal representation in IEEE 754 single-precision floating-point number system:

   4 2 C E 8 0 0 0

   What decimal value does it represent?

   A. 39.25
   B. 51.625
   C. 78.5
   D. 103.25
   E. None of the above.

3. Which of the following equations is incorrect?

   A. $A \cdot B \cdot C + A \cdot B' = A \cdot C + A \cdot B'$

   B. $P \cdot Q \cdot R \cdot S \cdot T + P \cdot Q' \cdot R' \cdot S' \cdot T' = P$

   C. $((K \cdot L) \oplus (M \cdot N))' = (K \cdot L) \odot (M \cdot N)$

   D. $(v + (w \cdot x \cdot y \cdot z))' = v' \cdot w' + v' \cdot x' + v' \cdot y' + v' \cdot z'$

   E. None of the above.

4. What is the simplified POS expression of the following Boolean function F? Note that X denotes don't-care values.

$$F(A, B, C, D) = \Pi M(3, 5, 6, 12, 14) \cdot X(4, 7, 10, 11)$$

   A. $(A + B') \cdot (B' + D) \cdot (B + C' + D')$

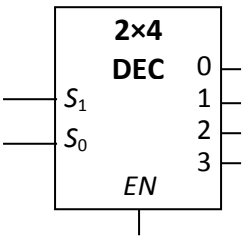
   B. $(A' + D') \cdot (B + C) \cdot (B + D)$

   C. $(A + B') \cdot (B' + D)$

   D. $(A' + B) \cdot (B + D')$

   E. None of the above.

5. Which of the following Boolean functions can be implemented using a single 2×4 decoder with 1-enable and active high outputs as shown below, with at most one 2-input AND gate, OR gate, or XOR gate? Note that complemented literals are <u>not</u> available.



   (i) $F1(A, B, C, D) = A' \cdot B' \cdot C \cdot D + A \cdot B' \cdot C' \cdot D$

   (ii) $F2(A, B, C, D) = A \cdot B \cdot C \cdot D' + A' \cdot B' \cdot C' \cdot D$

   (iii) $F3(A, B, C, D) = A' \cdot B \cdot C' \cdot D' + A' \cdot B \cdot C \cdot D$

   A. None of (i), (ii) or (iii).

   B. Only (ii).

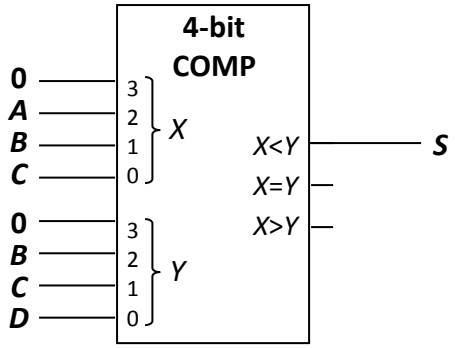
   C. Only (i) and (iii).

   D. Only (ii) and (iii).

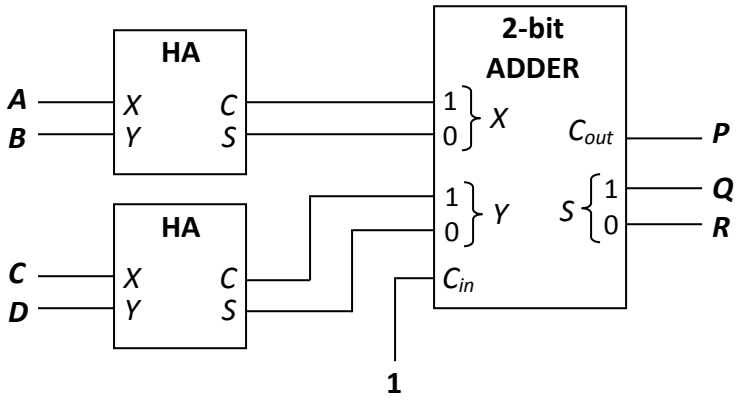
   E. All of (i), (ii) and (iii).

Questions 6 – 11: Write your answer in the space provided on the **Answer Sheet**. You do not need to show workings, unless otherwise stated.

6. [2 marks]
Given the following circuit, write the Boolean function $S(A,B,C,D)$ in Σm form.



7. [4 marks]
The circuit below uses two half adders and one 2-bit parallel adder. Fill in the truth table on the answer sheet.



8. [4 marks]
Given this code:

{ 010011, 001100, 111101, 110100, 000000 }

(a) What is the code's efficiency? [2 marks]

(b) What is the code's Hamming distance? [2 marks]

9. [6 marks]

(a) Given a 3-bit code *ABC*, you are to append a parity bit *P* to the code. If odd parity scheme is used, what is the correct parity bit for each of the following? [2 marks]

(i) *ABC* = 010
(ii) *ABC* = 101

(b) Suppose a 4-bit code *ABCP* is used, where *P* is the parity bit as defined in part (a) above. A device takes *ABCP* as its input and generates an output *Z* for valid inputs, where *Z* is 1 if the valid input represents a prime number (for example, *ABC* = 010), or 0 if the valid input does not represent a prime number (for example, *ABC* = 100).

Write the **simplified SOP expression** for *Z*(*A*,*B*,*C*,*P*). [2 marks]

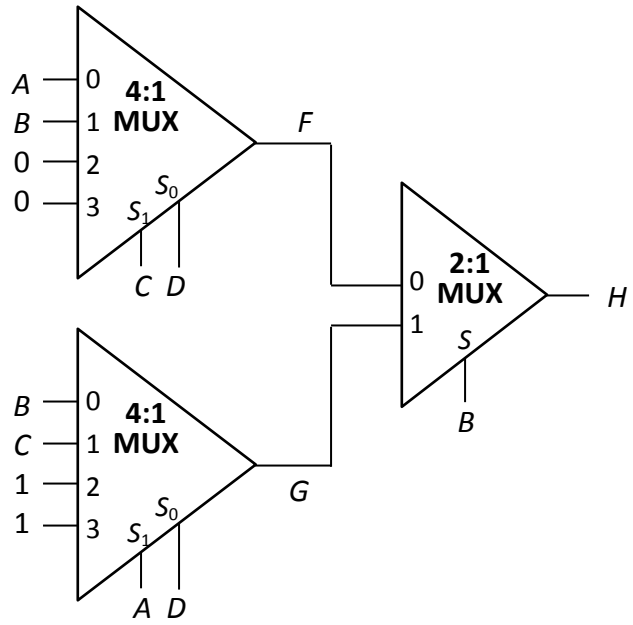
(c) [Marks for this part will only be awarded if your answer for part (b) above is correct.]

According to your answer for part (b), what is the value of *Z* the device generates for each of the following inputs? [2 marks]

(i) *ABCP* = 0110
(ii) *ABCP* = 1001

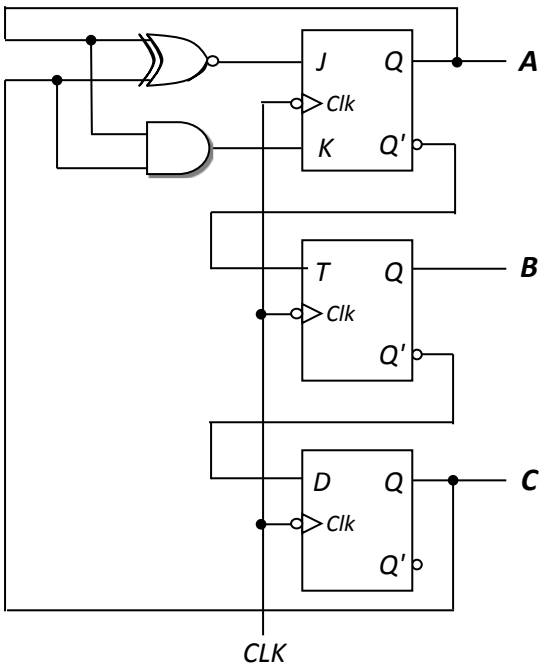
10. [7 marks]

Study the circuit below which implements *H*(*A*,*B*,*C*,*D*). Two intermediate outputs are marked as *F* and *G*.



Write the **simplified SOP expressions** for *F*, *G* and *H*.

11. [7 marks]
The following sequential circuit cycles through 7 states *ABC*. One state is unused. The circuit is implemented using a *JK* flip-flop for *A*, a *T* flip-flop for *B*, and a *D* flip-flop for *C*.



On the answer sheet, complete the state diagram by filling in the state numbers which are in decimal, as well as the state transition from the unused state. Two states (000 or 0 in decimal, and 111 or 7 in decimal) have been filled for you.

Is the circuit self-correcting and why? (No mark will be given if the explanation is incorrect.)

——— END OF PAPER ———

(Blank truth tables, K-maps and state table are provided in the next two pages.)

This page is for your rough work.

A	*B*	*C*	*D*	
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

A	*B*	*C*	*D*	
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

A	*B*	*C*	*D*			
0	0	0	0			
0	0	0	1			
0	0	1	0			
0	0	1	1			
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0			
1	0	0	1			
1	0	1	0			
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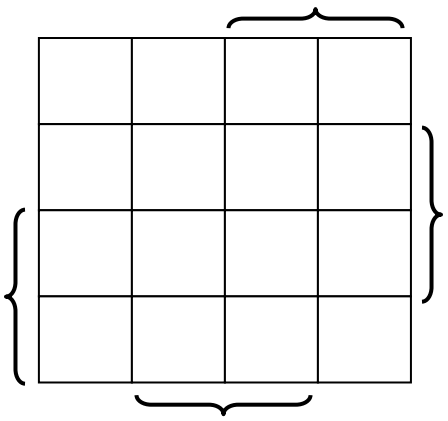
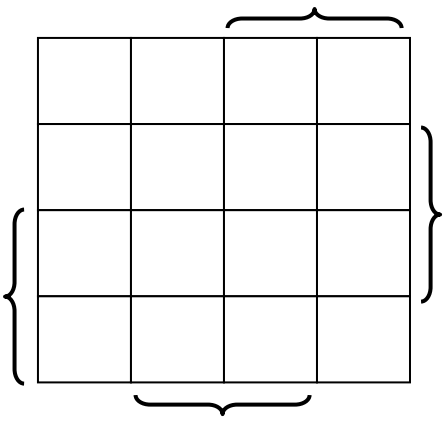
1	1	1	0			
1	1	1	1			





This page is for your rough work.

A	*B*	*C*							
0	0	0							
0	0	1							
0	1	0							
0	1	1							
1	0	0							
1	0	1							
1	1	0							
1	1	1							