NATIONAL UNIVERSITY OF SINGAPORE

CS2100 – COMPUTER ORGANISATION

(Semester 2: AY2021/22)

ANSWER SHEETS

Time Allowed: 2 Hours

INSTRUCTIONS

1. These ANSWER SHEETS consist of **FIVE (5)** printed pages.

2. Answer **ALL** questions on these Answer Sheets. You are to submit only these Answer Sheets and not the question paper. You may write in pen or pencil.

3. Printed/written materials are allowed. Apart from calculators, electronic devices are not allowed.

4. The maximum mark of this assessment is 100.

5. Do <u>not</u> write your name. Write your Student Number (eg: A0123456X) below.

A	0							

For internal use only

MCQs (12)	MRQs (18)	Q13 (12)	Q14 (16)	Q15 (13)	Q16 (13)	Q17 (16)	Total (100 marks)

=== END OF INSTRUCTIONS ===

CS2100

Write your answers for MCQs and MRQs in the boxes below, in **CAPITAL LETTERS**:

1 [ ]   2 [ ]   3 [ ]   4 [ ]   5 [ ]   6 [ ]

7 [ ]   8 [ ]   9 [ ]   10 [ ]   11 [ ]   12 [ ]

Excitation table:

Q	Q+	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Q13. Sequential circuits [12 marks]

(a) [5]
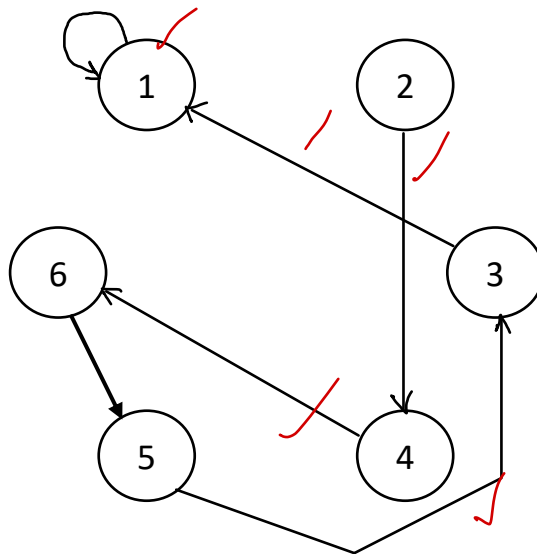
A	B	C	A+	B+	C+	JA	KA	JB	KB	JC	KC
0	0	0	1	0	0	1	0	0	1	0	0
0	0	1	0	0	1	0	1	0	1	0	0
0	1	0	1	0	0	1	0	0	1	0	0
0	1	1	0	0	1	0	1	0	1	0	0
1	0	0	1	1	0	1	0	1	1	0	0
1	0	1	0	1	1	0	1	1	1	0	0
1	1	0	1	0	1	1	0	1	1	1	0
1	1	1	0	0	1	0	1	1	1	1	0

(b) [1]

Self-correcting = no cycle among its invalid states.

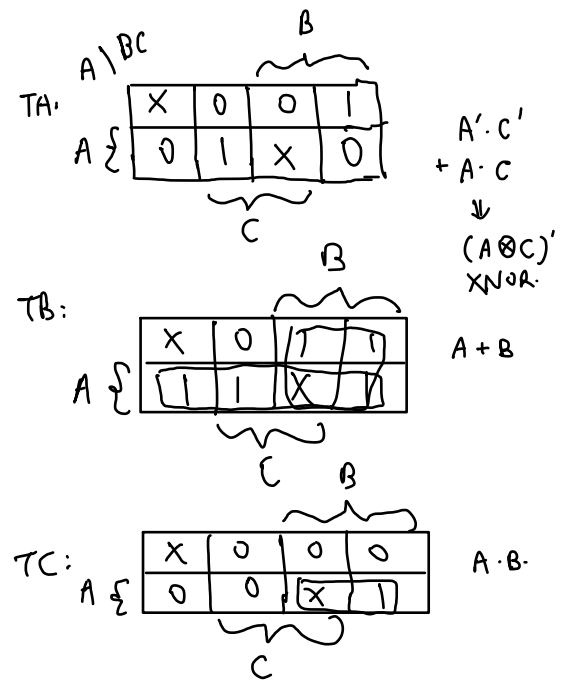∴ No. The invalid states 0 and 7 will transit to 4 and 1 respectively.

(c) [6]

$TA = (A \otimes C)'$

$TB = A + B$

$TC = A B$

Total: / 12

A	B	C	A⁺	B⁺	C⁺	TA	TB	TC
0	0	0	x	x	x	x	x	x
0	0	1	0	0	1	0	0	0
0	1	0	1	0	0	1	1	0
0	1	1	0	0	1	0	1	0
1	0	0	1	1	0	0	1	0
1	0	1	0	1	1	1	1	0
1	1	0	1	0	1	0	1	1
1	1	1	x	x	x	x	x	x

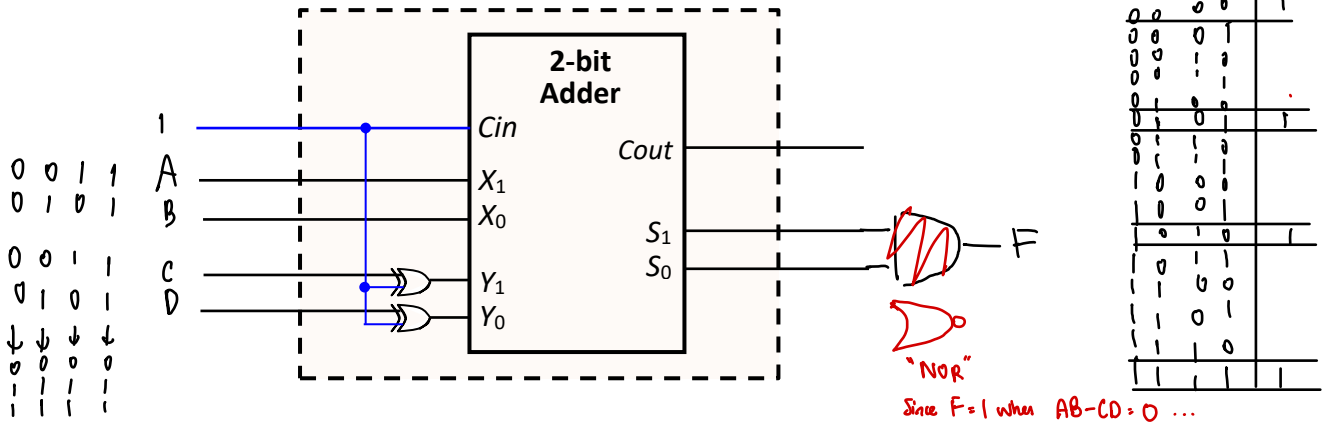A^+, B^+, C^+ column headers use superscript.

TA: $A \backslash BC$

$\overbrace{\qquad}^{B}$

x	0	0	1
0	1	x	0

A { (rows), $\underbrace{\qquad}_{C}$

$A' \cdot C' + A \cdot C$
↓
$(A \otimes C)'$
XNOR.

TB:

$\overbrace{\qquad}^{B}$

x	0	1	1
1	1	x	

A { (rows), $\underbrace{\qquad}_{C}$

$A + B$

TC:

$\overbrace{\qquad}^{B}$

x	0	0	0
0	0	x	1

A { (rows), $\underbrace{\qquad}_{C}$

$A \cdot B$

00 00
01 01
10 10
11 11

Q14. Combinational circuits [16 marks] $AB = CD$

(a) [4]

$F(A,B,C,D) = \Sigma m($ 0 , 5 , 10 , 15 $)$ ✓

(b) [4]

"NOR"
Since F=1 when AB-CD=0 ...

(c) [8]

(i) [2]
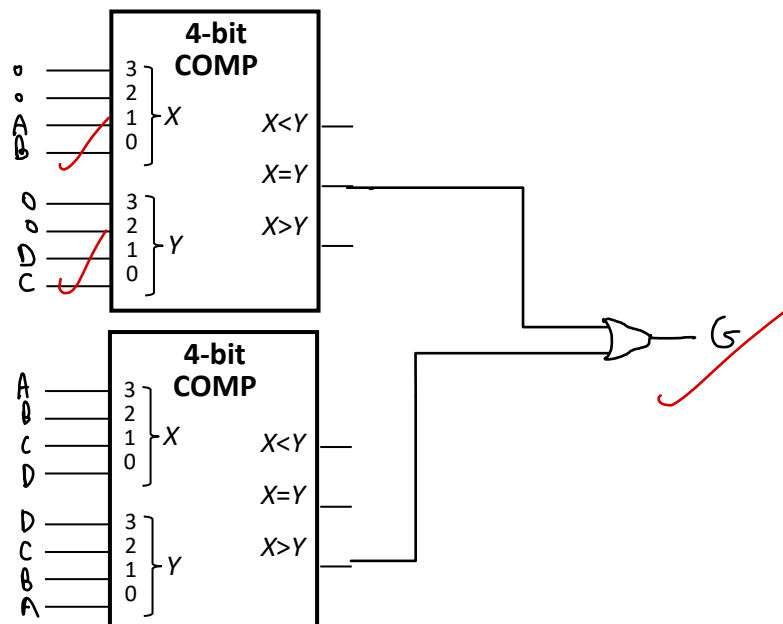
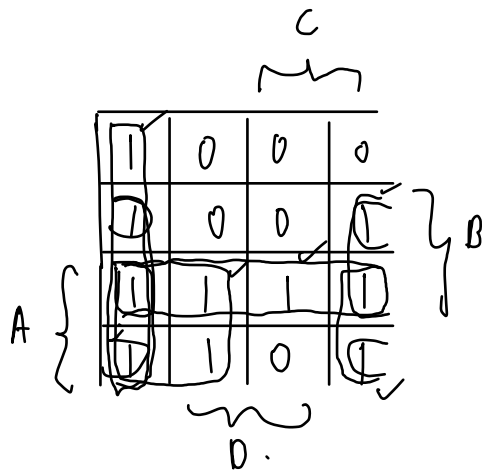Number of PIs = 7 ✗ 5

Number of EPIs = 5 ✓

(ii) [2]

Simplified SOP expression for G.

$G = A \cdot B$ ✗ $+ C' \cdot D$ ✓ $+ A \cdot D'$ ✓ $+ B \cdot D'$ ✓ $+ A \cdot C'$ ✓

(iii) [4]

Total: / 16

PI: ||||
EPI: 5

$A \cdot B + C' \cdot D' + A \cdot D' + B \cdot D' + A \cdot C'$

	AB CD		DCBA
0	0000	=	00 00
1	0001	<	10 00
2	0010	<	01 00
3	0011	<	11 00
4	0100	>	00 10
5	0101	<	10 10
6	0110	=	01 10
7	0111	<	11 10
8	1000	>	00 01
9	1001	=	10 01
10	1010	>	01 01
11	1011	<	11 01
12	1100	>	00 11
13	1101	>	10 11
14	1110	>	01 11
15	1111	=	1 1 11

$AB == 0$ or $AB >= CD$.

Q15. MIPS [13 marks]

(a)
[2]

Array B = $[1, 3, 2.5, 3, 8, 4, 5, 5, 4.]$

(b)
[4]

```
for (int i = 0; i < size; i++){
    int size_B = size * 2;
    if (i < size_B){
        if (A[i] < B[size_B]){
            int temp = B[size_B];
            B[size_B] = A[i];
            A[i] = temp;
        }
    }
}
```

(c)
[2]

```
  0      1      0  A   6   0   2   A
0000 00 01000 01011 01100 00000 10 1010
```

$0 \times 0108B02A$

(d)
[2]

$14 \times 4 = 56_{10}$
$= 38_{16}$

A B C D
10 11 12 13

4000BA
- 38
40004C

000010

addr: 0000 0100 2000 0000 0000 0100 1100

0×08100013

(e)
[3]

```
        add   $t9, $s1, $0    # I11
        add   $s1, $s2, $0    # I12
        add   $s2, $t9, $0    # I13
                $s2
skip:   sw    $s1, 0($t1)     # I14
                $s1
        sw    $s2, 0($t2)     # I15
skip:   addi  $t0, $t0, 4     # I16
```

Total: / 13

Q16. Pipelining [13 marks]

(a) [2] | 23

(b) [3]

(c) [3]

(d) [3]

(e) [2]

Total: / 13

Q17. Cache [16 marks]

(a)

(i) [2] Set index: _____ ; Byte offset: _____

(ii) [2] Number of misses: _____

(b) [2] Number of misses: _____

(c) [2] Index: _____ ; Byte offset: _____

(d) [4] Hits for array *A* = _____ ; Hits for array *B* = _____

(e) [4] Hits for array *A* = _____ ; Hits for array *B* = _____

Total: / 16

=== **END OF ANSWER SHEETS** ===