CS2100 Computer Organisation
AY2021/22 Semester 1
Assignment 2 Answer Sheet

FULL NAME:	
STUDENT ID:	
TUTORIAL GROUP:	

Question 0. Submission instructions (3 marks)

a. Name your file with your student number (eg: AxxxxxxxY>.pdf). (1 mark)	**Y / N**
b. Submit your assignment as a single PDF file. (1 mark)	**Y / N**
c. Your submission has your tutorial group number, student number and name. (1 mark)	**Y / N**

Question 1. Datapath (8 marks)

Field	Value
RegDst	X
MemRead	0
MemWrite	1
ALUSrc	1
RegWrite	0
Instruction[31-26] *	0b101011
Instruction[25-21] *	0b11101
Instruction[20-16] *	0b10010
Instruction[15-11] *	0b11111
Instruction[5-0] *	0b011000
❶ * (output from sign-extend)	0x**FFFF FFD8**
❷ *	0x**0000 0004**
❸ *	0x**0000 00A4**
❹ * (read data 2)	0x**0004 0200**
❺ *	0x**7FFF EFCC**
❻ (ALU control output)	0010

- $s2 = $18; $sp = $29; -40 = 0b1111 1111 1111 1111 1111 1111 1101 1000.
- Instruction encoding = 0b[101011] [11101] [10010] [1111 1111 1101 1000].
- ❷: 0xFFFFFFD8<<2 + 0x000000A4 = 0x00000004.
- ❺: 0x7FFFEFF4 + 0xFFFFFFD8 = 0x7FFFEFCC.

Question 2. Simplification (14 marks)

(a) $B{\cdot}Y{\cdot}E'{\cdot}(A'{\cdot}X + A{\cdot}X' + A{\cdot}X + A'{\cdot}X') + B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y + Y{\cdot}E'{\cdot}S'$ [6 marks]

$B{\cdot}Y{\cdot}E'{\cdot}(\underline{A'{\cdot}X + A{\cdot}X' + A{\cdot}X + A'{\cdot}X'}) + B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y + Y{\cdot}E'{\cdot}S'$

Step 1: $= B{\cdot}Y{\cdot}E'{\cdot}(\underline{A'{\cdot}X' + A'{\cdot}X} + \underline{A{\cdot}X' + A{\cdot}X}) + B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y + Y{\cdot}E'{\cdot}S'$ (associative law; commutative law)

Step 2: $= B{\cdot}Y{\cdot}E'{\cdot}(A'{\cdot}\underline{(X'+X)} + A{\cdot}\underline{(X'+X)}) + B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y + Y{\cdot}E'{\cdot}S'$ (distributive law)

Step 3: $= B{\cdot}Y{\cdot}E'{\cdot}(\underline{A'{\cdot}1} + \underline{A{\cdot}1}) + B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y + Y{\cdot}E'{\cdot}S'$ (complement law)

Step 4: $= B{\cdot}Y{\cdot}E'{\cdot}(\underline{A' + A}) + B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y + Y{\cdot}E'{\cdot}S'$ (identity law)

Step 5: $= \underline{B{\cdot}Y{\cdot}E'{\cdot}1} + B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y + Y{\cdot}E'{\cdot}S'$ (complement law)

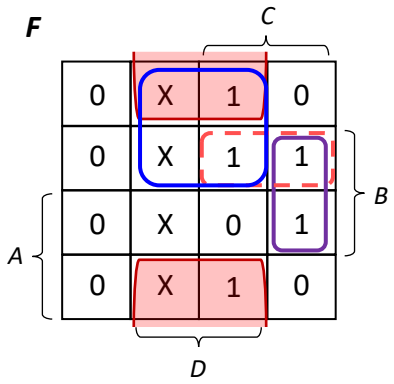
Step 6: $= B{\cdot}Y{\cdot}E' + \underline{B'{\cdot}L{\cdot}U{\cdot}E'{\cdot}S'{\cdot}K{\cdot}Y} + Y{\cdot}E'{\cdot}S'$ (identity law)

Step 7: $= B{\cdot}Y{\cdot}E' + \underline{Y{\cdot}E'{\cdot}S'{\cdot}(B'{\cdot}L{\cdot}U{\cdot}K) + Y{\cdot}E'{\cdot}S'}$ (associative law; commutative law)

Step 8: $= B{\cdot}Y{\cdot}E' + Y{\cdot}E'{\cdot}S'$ (absorption theorem 1)

Step 9: $= Y{\cdot}E'{\cdot}(B + S')$ (distributive law)

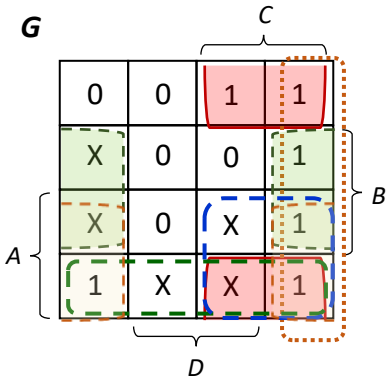
(b)



[4 marks]

#PIs	4 ($A'{\cdot}D$, $B'{\cdot}D$, $B{\cdot}C{\cdot}D'$, $A'{\cdot}B{\cdot}C$)
#EPIs	2 ($B'{\cdot}D$, $B{\cdot}C{\cdot}D'$)
Simplest SOP	$B'{\cdot}D + B{\cdot}C{\cdot}D' + A'{\cdot}D$
Simplest POS	$C \cdot (B+D) \cdot (A'+B'+D')$

(c)

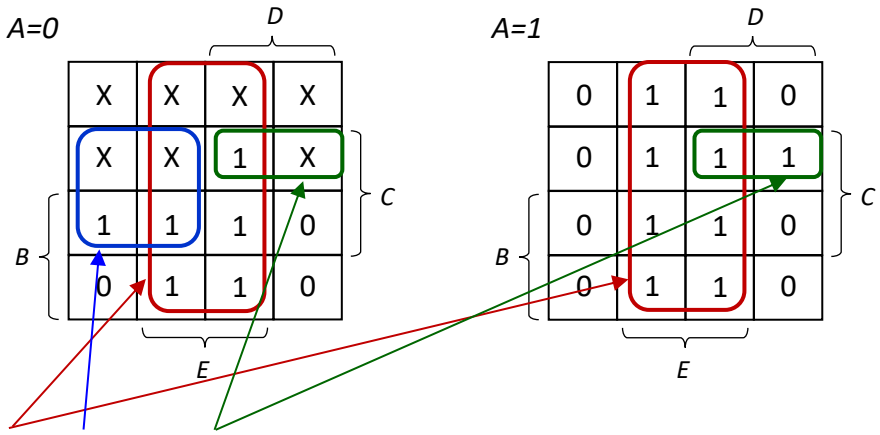


[4 marks]

#PIs	6 ($B'{\cdot}C$, $C{\cdot}D'$, $B{\cdot}D'$, $A{\cdot}B'$, $A{\cdot}D'$, $A{\cdot}C$)
#EPIs	1 ($B'{\cdot}C$)
Simplest SOP	$B'{\cdot}C + B{\cdot}D' + A{\cdot}B'$ or $B'{\cdot}C + B{\cdot}D' + A{\cdot}D'$ or $B'{\cdot}C + C{\cdot}D' + A{\cdot}B'$ or $B'{\cdot}C + C{\cdot}D' + A{\cdot}D'$
Simplest POS	$(A+C) \cdot (B'+D')$

Question 3. Circuit Design (8 marks)

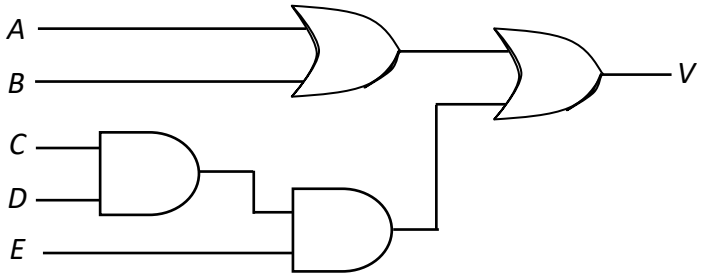
(a) [2 marks]



(b) $M = E + A' \cdot C \cdot D' + B' \cdot C \cdot D$ [3 marks]

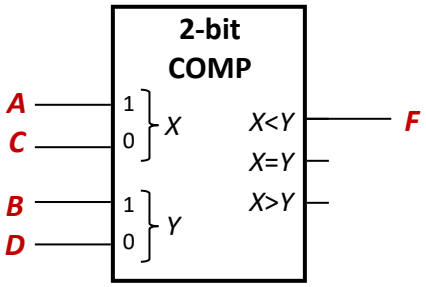
(c) Draw the circuits for V. [3 marks]

$V = A + B + C \cdot D \cdot E$



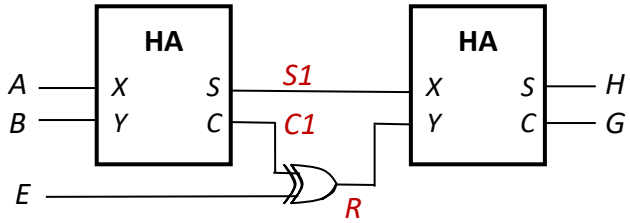
Question 4. Block-level design (7 marks)

(a) $F(A,B,C,D) = \Sigma m(1, 4, 5, 6, 7, 13)$ [3 marks]

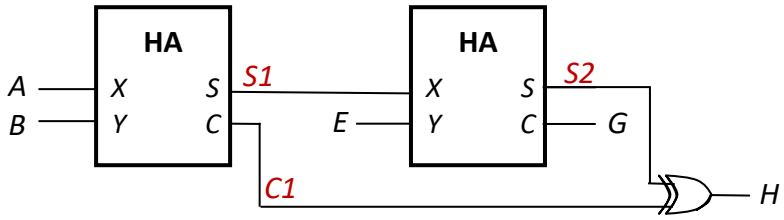


(b) $G(A,B,E) = \Sigma m(3,5)$

$H(A,B,E) = \Sigma m(1,2,4,6)$ [4 marks]



A	B	E	S1	C1	R = E ⊕ C1	G	H
0	0	0	0	0	0	0	0
0	0	1	0	0	1	0	1
0	1	0	1	0	0	0	1
0	1	1	1	0	1	1	0
1	0	0	1	0	0	0	1
1	0	1	1	0	1	1	0
1	1	0	0	1	1	0	1
1	1	1	0	1	0	0	0



A	B	E	S1	C1	S2	G	H = S2 ⊕ C1
0	0	0	0	0	0	0	0
0	0	1	0	0	1	0	1
0	1	0	1	0	1	0	1
0	1	1	1	0	0	1	0
1	0	0	1	0	1	0	1
1	0	1	1	0	0	1	0
1	1	0	0	1	0	0	1
1	1	1	0	1	1	0	0