Final Exam S1
Computer Architecture

Duration: 1 hr. 30 min.

Last name: .... First name: .... Group: ....

Write answers only on the worksheet.
Do not show any calculation unless you are explicitly asked.
Do not use red ink.

Exercise 1 (2 points)

Convert the following numbers from the source form into the destination form. Do not write down the result in a fraction or a power form (e.g. write down 0.25 and not ¼ or 2^{-2}).

| Number to Convert	Source Form	Destination Form	Result
101011101.0101	Binary	Decimal	
1E2.5	Hexadecimal	Decimal	
750	Decimal	Base 5	
1707.66	Hexadecimal	Base 8	

Exercise 2 (5 points)

Perform the following 8-bit binary operations (the two operands and the result are 8 bits wide). Then, convert the result into unsigned and signed decimal values. If an overflow occurs, write down 'ERROR' instead of the decimal value.

Operation	Binary Result	Decimal Value	
		Unsigned	**Signed**
10110111 + 00101101			
01011010 - 10001101			
01110111 + 11111000			
10000001 - 10000000			
11010111 - 01111100			

Exercise 3 (3 points)

We want to simplify the following circuit diagram:
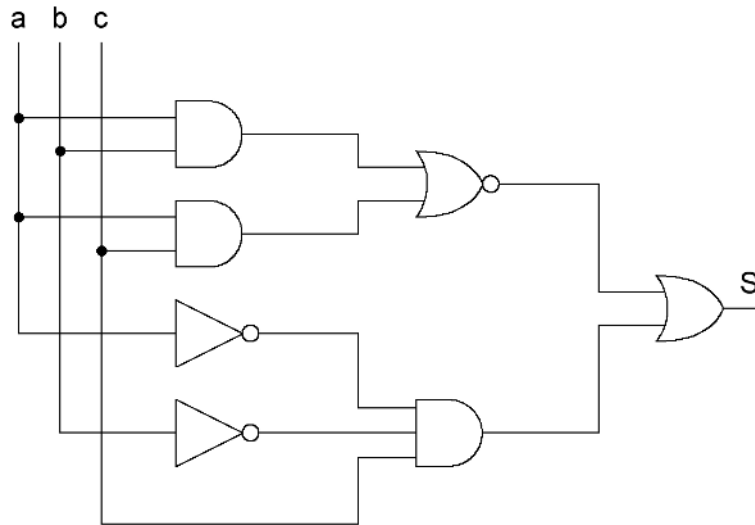
1. Without any simplifications, give the *S* output in terms of *a*, *b* and *c*.
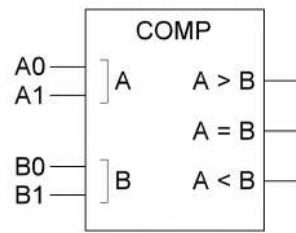
S =

2. Give the most simplified expression of *S*.

S =

3. From the most simplified expression, draw a new circuit diagram by using three NOT gates, one two-input AND gate and one two-input OR gate.

Exercise 4 (4 points)

We want to design the following comparator:

The *A* and *B* inputs are 2-bit unsigned integers (*A0* and *B0* are the LSBs):

- If $A > B$, the '*A > B*' output is set to 1 and the other outputs are set to 0.
- If $A = B$, the '*A = B*' output is set to 1 and the other outputs are set to 0.
- If $A < B$, the '*A < B*' output is set to 1 and the other outputs are set to 0.

1. Complete the following truth table:

A1	A0	B1	B0	A > B	A = B	A < B
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			

2. Without using Karnaugh maps, give the most simplified expression of the '*A = B*' output. **Use the EXCLUSIVE-OR operator to simplify the expression.**

'A = B' =

3. Complete the Karnaugh maps below (circles included) and give the most simplified expressions of the $'A > B'$ and $'A < B'$ outputs. **No points will be given to an expression if its Karnaugh map is wrong.**

B1 B0

A > B	00	01	11	10
00				
01				
11				
10				

A1 A0

B1 B0

A < B	00	01	11	10
00				
01				
11				
10				

A1 A0

'A > B' =

'A < B' =

Exercise 5 (6 points)

Let us consider the truth tables below. A, B, C and D are the inputs. U, V, W, X, Y and Z are the outputs.

A	B	C	U	V
0	0	0	0	1
0	0	1	1	1
0	1	0	0	1
0	1	1	1	1
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	0	1

A	B	C	D	Y	Z
0	0	0	0	0	1
0	0	0	1	0	0
0	0	1	0	0	1
0	0	1	1	Φ	0
0	1	0	0	0	0
0	1	0	1	0	Φ
0	1	1	0	0	0
0	1	1	1	Φ	Φ
1	0	0	0	Φ	1
1	0	0	1	Φ	0
1	0	1	0	1	1
1	0	1	1	1	0
1	1	0	0	1	0
1	1	0	1	1	Φ
1	1	1	0	1	0
1	1	1	1	1	Φ

A	B	C	W	X
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	0	0

1. Write down the minterm canonical form of *U*.

U =

2. Write down the maxterm canonical form of *V*.

V =

3. Complete the Karnaugh maps below (circles included) and give the most simplified expression for each output. **No points will be given to an expression if its Karnaugh map is wrong. For the time being, do not simplify by using the EXCLUSIVE-OR operator.**

BC

W	00	01	11	10
0				
1				

A

W =

C

X	0	1
00		
01		
11		
10		

AB

X =

CD

Y	00	01	11	10
00				
01				
11				
10				

AB

Y =

CD

Z	00	01	11	10
00				
01				
11				
10				

AB

Z =

4. See if some of the *W*, *X*, *Y* and *Z* outputs can be simplified by using the EXCLUSIVE-OR operator. If so, simplify them and write down the new expressions (do not show any calculation).

Feel free to use the blank space below if you need to: