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
11011101.101	Binary	Decimal	
C9.A	Hexadecimal	Decimal	
750	Decimal	Base 6	
1707.66	Base 8	Hexadecimal	

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**
10100111 - 00111101			
11011010 - 10001101			
01110111 + 11110000			
10000000 - 10000000			
01110111 - 11110000			

Exercise 3 (4 points)

A tank of 1,000 liters is fitted with three sensors: $C1$, $C2$ and $C3$.

- $C1$ is placed at the first quarter of the tank.
- $C2$ is placed at the middle of the tank.
- $C3$ is placed at the third quarter of the tank.

A sensor generates a 1 when there is some liquid in front of it. Otherwise, it generates a 0.

The instrument panel has five indicator lights: $L0$, $L1$, $L2$, $L3$ and $L4$.

- $L1$ is switched on when the tank contains less than 250 liters.
- $L2$ is switched on when the tank contains between 250 and 500 liters.
- $L3$ is switched on when the tank contains between 500 and 750 liters.
- $L4$ is switched on when the tank contains more than 750 liters.
- $L0$ is switched on when an error occurs (the indicator lights from $L1$ to $L4$ are then automatically switched off). For instance, if the tank is full and $C3$ is 1 and $C2$ is 1 and $C1$ is 0, it means that the $C1$ sensor has a defect. Therefore, the $L0$ indicator light is switched on.

1. Complete the truth table below.
2. Give the most simplified expressions of $L1$, $L2$, $L3$ and $L4$ (you do not have to use Karnaugh maps).
3. Complete the Karnaugh map for L0 (also draw **circles**) and give its most simplified expression.

C3	C2	C1	L1	L2	L3	L4	L0
0	0	0					
0	0	1	0	1	0	0	0
0	1	0					
0	1	1					
1	0	0					
1	0	1					
1	1	0	0	0	0	0	1
1	1	1					

L1 =	L3 =
L2 =	L4 =

$C2\ C1$

L0	00	01	11	10
0				
1				

$C3$

L0 =

Exercise 4 (6 points)

1. Complete the Karnaugh maps below (circles included) and give the most simplified expressions for X and Y. Do not simplify by using the EXCLUSIVE-OR operator. **No points will be given to an expression if its Karnaugh map is wrong.**

CD

X	00	01	11	10
00	1	0	1	1
01	1	0	0	1
11	0	0	1	1
10	1	0	0	1

AB

CD

Y	00	01	11	10
00	Φ	Φ	Φ	Φ
01	Φ	Φ	Φ	Φ
11	0	0	1	1
10	1	0	0	1

AB

$X =$

$Y =$

2. Simplify X by using the EXCLUSIVE-OR operator.

X =

3. Write down the minterm canonical form of Y from its most simplified expression (it contains three variables only: B, C and D).

Y =

4. Write down the maxterm canonical form of Y from its most simplified expression (it contains three variables only: B, C and D).

Y =

5. If $A = 1$, then $X = Y$ (answer true or false).

Exercise 5 (3 points)

Give the most simplify expressions for all the following expressions (do not show any calculation).

Expression	Most Simplified Expression
A.B + A.(B + C) + B.(B + C)	
A.B.C + A.$\overline{B}$.C + A.B.$\overline{C}$.D	
A + B.C + $\overline{A}$.($\overline{B}$ + $\overline{C}$).(A.D + C)	

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