

Key to 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 $\frac{1}{4}$ or 2^{-2}).

Number to Convert	Source Form	Destination Form	Result
11011101.101	Binary	Decimal	221.625
C9.A	Hexadecimal	Decimal	201.625
750	Decimal	Base 6	3250
1707.66	Base 8	Hexadecimal	3C7.D8

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	01101010	106	ERROR
11011010 - 10001101	01001101	77	77
01110111 + 11110000	01100111	ERROR	103
10000000 - 10000000	00000000	0	0
01110111 - 11110000	10000111	ERROR	ERROR

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	1	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	0	0	0	0	1
0	1	1	0	0	1	0	0
1	0	0	0	0	0	0	1
1	0	1	0	0	0	0	1
1	1	0	0	0	0	0	1
1	1	1	0	0	0	1	0

$L1 = \overline{C3}.\overline{C2}.\overline{C1}$	$L3 = \overline{C3}.C2.C1$
$L2 = \overline{C3}.C2.C1$	$L4 = C3.C2.C1$

		$C2\ C1$			
		00	01	11	10
$C3$	0	0	0	0	1
	1	1	1	0	1

$$L0 = C3.\overline{C2} + C2.\overline{C1}$$

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
AB	00	1	0	1	1
	01	1	0	0	1
	11	0	0	1	1
	10	1	0	0	1

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

$$X = \bar{B}.D + \bar{A}.D + \bar{A}.B.C + A.B.C$$

$$Y = \bar{B}.D + B.C$$

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

$$X = \bar{B}.D + \bar{A}.D + C.A \oplus B$$

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

$$Y = B.C.D + B.C.\bar{D} + \bar{B}.C.\bar{D} + \bar{B}.\bar{C}.\bar{D}$$

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

$$Y = (B + C + \bar{D}).(B + \bar{C} + \bar{D}).(\bar{B} + C + D).(\bar{B} + C + \bar{D})$$

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

True

Exercise 5 (3 points)

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

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

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