# 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 a pencil or 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 |
|---|---|---|---|
| 101011011.01011 | Binary | Decimal | **347.34375** |
| B09.58 | Hexadecimal | Decimal | **2825.34375** |
| 999 | Decimal | Base 9 | **1330** |
| 3245.43 | Base 8 | Hexadécimale | **6A5.8C** |

## 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 |
| 11000111 + 10000101 | 01001100 | **ERROR** | **ERROR** |
| 01010110 - 11110101 | 01100001 | **ERROR** | **97** |
| 00101110 - 10101100 | 10000010 | **ERROR** | **ERROR** |
| 11010001 + 00001010 | 11011011 | **219** | **-37** |
| 01101011 - 01001000 | 00100011 | **35** | **35** |

## Exercise 3 (5 points)

According to the truth table, complete the the Karnaugh maps below (**draw also the circles**). Then, give the most simplified expression for *W*, *X*, *Y* and *Z* (do not simplify by using the EXCLUSIVE-OR operator). **No points will be given to an expression if its Karnaugh map is wrong.** Note that when *DCBA* > $1001_2$, then *W*, *X*, *Y* and *Z* are undefined.

| D | C | B | A | W | X | Y | Z |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |

**BA**

| **DC** \ **W** | **00** | **01** | **11** | **10** |
|---|---|---|---|---|
| **00** | 0 | 0 | 0 | 0 |
| **01** | 0 | 1 | 1 | 1 |
| **11** | Φ | Φ | Φ | Φ |
| **10** | 1 | 1 | Φ | Φ |

**W** = D + C.A + C.B

**BA**

| **DC** \ **X** | **00** | **01** | **11** | **10** |
|---|---|---|---|---|
| **00** | 0 | 0 | 1 | 0 |
| **01** | 1 | 0 | 0 | 0 |
| **11** | Φ | Φ | Φ | Φ |
| **10** | 1 | 1 | Φ | Φ |

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

**BA**

| **DC** \ **Y** | **00** | **01** | **11** | **10** |
|---|---|---|---|---|
| **00** | 0 | 0 | 0 | 1 |
| **01** | 0 | 0 | 1 | 0 |
| **11** | Φ | Φ | Φ | Φ |
| **10** | 0 | 0 | Φ | Φ |

**Y** = C.B.A + $\overline{C}$.B.$\overline{A}$

**BA**

| **DC** \ **Z** | **00** | **01** | **11** | **10** |
|---|---|---|---|---|
| **00** | 0 | 1 | 0 | 0 |
| **01** | 1 | 0 | 0 | 1 |
| **11** | Φ | Φ | Φ | Φ |
| **10** | 0 | 1 | Φ | Φ |

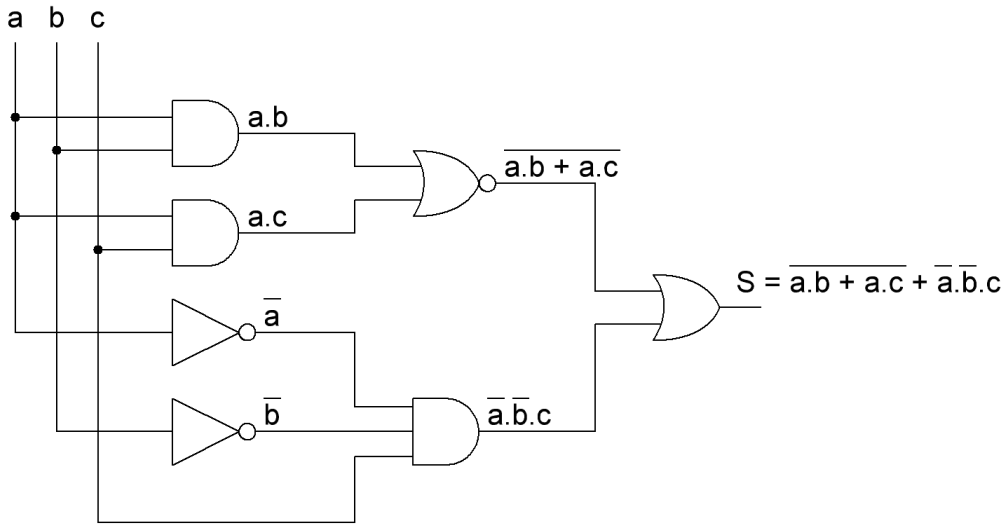
**Z** = C.$\overline{A}$ + $\overline{C}$.$\overline{B}$.A

Finally, simplify *Y* by using the EXCLUSIVE-OR operator:

**Y** = C.B.A + $\overline{C}$.B.$\overline{A}$ = B.(C.A + $\overline{C}$.$\overline{A}$) = **B . $\overline{\mathbf{C \oplus A}}$**

## Exercise 4 (3 points)

We want to simplify the following circuit diagram:



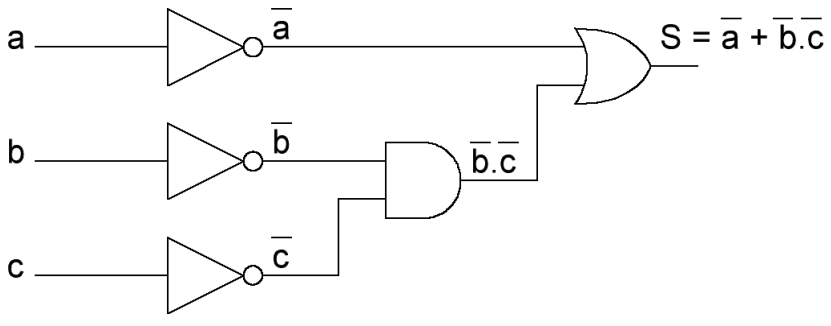

1. Without any simplifications, give the *S* output in terms of *a*, *b* and *c*.

**S = $\overline{\mathbf{a.b + a.c}}$ + $\overline{\mathbf{a}}.\overline{\mathbf{b}}.\mathbf{c}$**

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

**S = $\overline{\mathbf{a}}$ + $\overline{\mathbf{b}}.\overline{\mathbf{c}}$**

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 5 (5 points)

Let us consider the three following expressions:

$S1 = \overline{(A + \overline{B} + C).(A + \overline{C}).(\overline{A} + \overline{B})}$

$S2 = A.B.C + A.\overline{B}.\overline{C} + \overline{A}.B.\overline{C} + A.\overline{B}.C$

$S3 = A \oplus (B.\overline{C})$

1. Give the most simplified expression of *S1*. **The result must be given as a sum of products (without parentheses)**.

| |
|---|
| **$S1 = B + \overline{A}.C$** |

2. Write down the minterm canonical form of *S1*.

| |
|---|
| **$S1 = A.B.C + A.B.\overline{C} + \overline{A}.B.C + \overline{A}.B.\overline{C} + \overline{A}.\overline{B}.C$** |

3. Write down the maxterm canonical form of *S2*.

| |
|---|
| **$S2 = (A + B + C).(A + B + \overline{C}).(A + \overline{B} + \overline{C}).(\overline{A} + \overline{B} + C)$** |

4. Is it true that S2 = S3? (Answer “Yes” or “No”)

| |
|---|
| **Yes** |

5. Determine the *m* and *n* integers so that the following identity is true: $2^m - 2^n = 4064$

| | |
|---|---|
| **m = 12** | **n = 5** |

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