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
110111011.01101	Binary	Decimal	**443.40625**
A34.68	Hexadecimal	Decimal	**2612.40625**
528	Decimal	Base 5	**4103**
375.25	Base 8	Hexadecimal	**FD.54**

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**
10010111 - 10101101	11101010	**ERROR**	**-22**
01010010 + 11001101	00011111	**ERROR**	**31**
00110110 - 10111100	01111010	**ERROR**	**122**
10010001 - 10000010	00001111	**15**	**15**
01000111 + 01001100	10010011	**147**	**ERROR**

Exercise 3 (6 points)

For the whole exercise, the variables from *S1* to *S6* can be either 0 or 1. Complete the Karnaugh maps below (circles included) and give their most simplified expressions. **No points will be given to an expression if its Karnaugh map is wrong.**

1. Let us consider *N*, a 3-bit binary number (*C*, *B*, *A*). *A* is the least significant bit.
   - S1 = 1 when N = 1, 3, 4, 5
   - S2 = 1 when N = 0, 2, 4, 5, 6, 7

BA

S1	00	01	11	10
0	0	1	1	0
1	1	1	0	0

C

BA

S2	00	01	11	10
0	1	0	0	1
1	1	1	1	1

C

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

$S2 = \overline{A} + C$

2. Let us consider *N*, a 4-bit binary number (*D*, *C*, *B*, *A*). *A* is the least significant bit.
   - S3 = 1 when N = 0, 1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 15
   - S4 = 1 when N = 0, 1, 4, 6, 8, 9, 12, 14
   - S5 = 1 when N = 5, 7, 13, 15 and S5 is undefined when N = 0, 2, 8, 10
   - S6 = 1 when N = 2, 6 and S6 is undefined when N = 0, 1, 4, 5, 8, 9, 12, 13

BA

S3	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	0	1	1	0
10	0	1	1	0

DC

BA

S4	00	01	11	10
00	1	1	0	0
01	1	0	0	1
11	1	0	0	1
10	1	1	0	0

DC

$S3 = \overline{D} + A$

$S4 = \overline{C}.\overline{B} + C.\overline{A}$

BA

S5	00	01	11	10
00	Φ	0	0	Φ
01	0	1	1	0
11	0	1	1	0
10	Φ	0	0	Φ

DC

BA

S6	00	01	11	10
00	Φ	Φ	0	1
01	Φ	Φ	0	1
11	Φ	Φ	0	0
10	Φ	Φ	0	0

DC

$S5 = C.A$

$S6 = \overline{D}.\overline{A}$

Exercise 4 (7 points)

For the whole exercise, write down the result only (do not show any calculation).

Let us consider the two following expressions:

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

$S2 = \overline{A}.(\overline{A + BC}).(A.D + C) + \overline{A}.C$

1. Give the most simplified expressions of *S1* and *S2*. **The result must be given as a sum of products (without parentheses)**.

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

$S2 = \overline{A}.C$

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

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

3. Write down the maxterm canonical form of *S1*.

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

4. If *A = 1*, give the most simplified expression of *S1*.
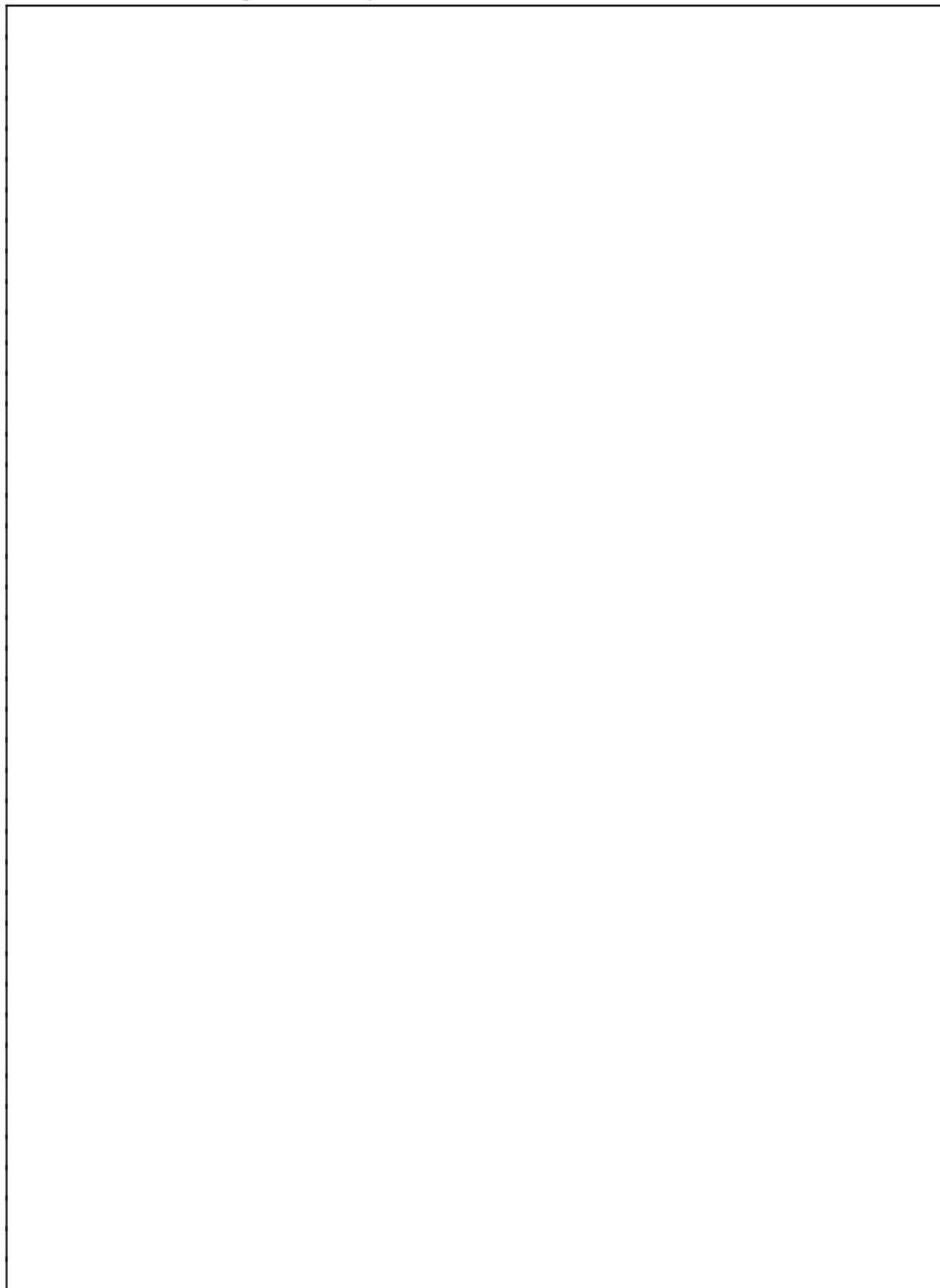
$S1 = \overline{B}$

5. Simplify the following expression by using the EXCLUSIVE-OR operator: $A + B.C.D + B.\overline{C}.\overline{D}$

$A + B.\overline{C \oplus D}$

6. Simplify the following expression by using the EXCLUSIVE-OR operator: $B.C + \overline{A}.B + A.\overline{B}.\overline{C}$

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

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