# Examination 2
# Computer Architecture

**Duration: 1 hr 30 min.**

Family name: ..... First name: ..... Class: .....

**Answer on the worksheet.**
**Do not show any calculation unless you are explicitly asked.**
**Do not use a pencil or red ink.**

## Exercise 1 (5 points)

Simplify the expressions below as much as possible. The result must not contain parentheses.

| Non-simplified expression | Most simplified expression (no parentheses) |
|---|---|
| $(\overline{A} + \overline{B}).(\overline{A} + \overline{C}) + \overline{A}.\overline{B}.C$ | |
| $\overline{\overline{B}.D} \cdot \overline{A.D} \cdot (A + D).A.B$ | |
| $(A + \overline{B} + C).(A + \overline{C}).(\overline{A} + \overline{B})$ | |
| $\overline{\overline{A}.B} \cdot (A + B) + C.\overline{A.\overline{B}}$ | |
| $A + \overline{\overline{B} + \overline{D}} + \overline{A}.(\overline{B \cdot D}).(A.C + D)$ | |

## Exercise 2 (5 points)

1. Write down the minterm canonical form for the following expressions.

| Expression | Minterm canonical form |
|---|---|
| $A + B$ | |
| $\overline{A} \cdot (\overline{B} + \overline{C})$ | |
| $\overline{A + B} \cdot (\overline{C} + \overline{D})$ | |

2. Write down the maxterm canonical form for the following expressions.

| Expression | Maxterm canonical form |
|---|---|
| $(A + B).(B + C)$ | |
| $A + B + C.D$ | |

## Exercise 3 (6 points)

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 = 0, 3, 6, 7
   - S2 = 1 when N = 0, 2, 4, 6 and S2 is undefined when N = 1, 5

| C \ BA | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | | | |
| 1 | | | | |

**S1 =**

| C \ BA | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | | | |
| 1 | | | | |

**S2 =**

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, 4, 5, 6, 7, 9, 11
   - S4 = 1 when N = 0, 1, 2, 3, 4, 6, 8, 9, 10, 11
   - S5 = 1 when N = 0, 2, 4, 5, 6, 8, 12, 13, 14 and S5 is undefined when N = 10, 11, 15
   - S6 = 1 when N = 2, 3, 6, 7, 10, 11, 14, 15 and S6 is undefined when N = 1, 4, 5, 9, 12, 13

| DC \ BA | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

**S3 =**

| DC \ BA | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

**S4 =**

| DC \ BA | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

**S5 =**

| DC \ BA | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

**S6 =**

## Exercise 4 (4 points)

Let us consider two tanks: *R1* and *R2*. The liquid level of each tank is checked by two sensors: a high-level sensor (*A* for *R1*, *B* for *R2*) and a low-level sensor (*C* for *R1*, *D* for *R2*). The values of *A*, *B*, *C*, *D* are 1s when there is some liquid in front of the sensor; otherwise they are 0s. Three indicator lights (*V1*, *V2*, *V3*) are set according to the following conditions:

- *V1* = 1, if *R1* and *R2* are full.
- *V2* = 1, if *R1* and *R2* are empty.
- *V3* = 1, in any other cases.

1. Complete the truth table below. *A*, *B*, *C*, and *D* are the inputs. *V1*, *V2*, and *V3* are the outputs. If some cases are not possible for the outputs, use the symbol "Φ" (phi) which means 0 or 1.

| A | B | C | D | V1 | V2 | V3 |
|---|---|---|---|---|---|---|
| 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. Complete the Karnaugh maps below (**circles included**) and give the most simplified expressions for *V1*, *V2* and *V3*. **No points will be given to an expression if its Karnaugh map is wrong.**

| V1 | CD 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| AB 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

**V1 =**

| V2 | CD 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| AB 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

**V2 =**

| V3 | CD 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| AB 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

**V3 =**

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