# S2 – Key to Examination 3
# Computer Architecture

**Duration: 1 hr 30 min**

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

## Exercise 1 (7 points)

Complete the timing diagrams shown on the answer sheet (up to the last vertical dotted line) for the following circuits.

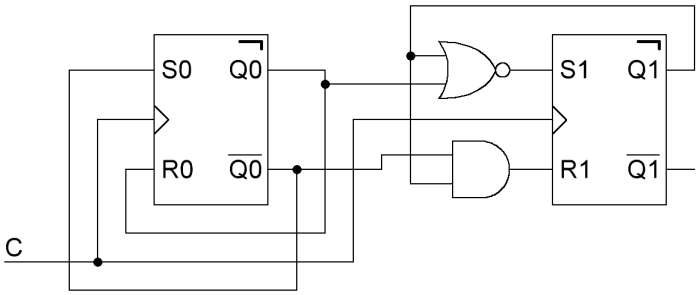


Figure 1

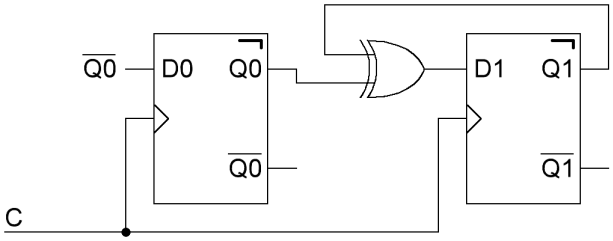


Figure 2

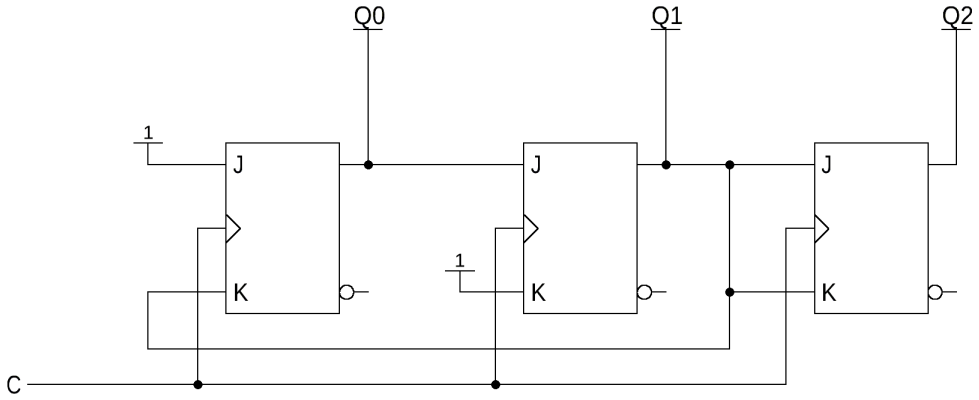


Figure 3

## Exercise 2 (6 points)

The table shown on the answer sheet gives the sequence of a counter we want to design. This counter should be made up of JK flip-flops.

1. Complete the table shown on the answer sheet.
2. Write down the most simplified expressions of *J* and *K* for each flip-flop on the answer sheet. **Complete the Karnaugh maps (circles included) for the solutions that are not obvious**. An obvious solution does not have any logical operations apart from the complement (for instance: J0 = 1, K1 = $\overline{Q2}$). **Do not use the EXCLUSIVE OR operator. No points will be given to an expression if its Karnaugh map is wrong.**

## Exercise 3 (4 points)

The table shown on the answer sheet gives the sequence of a counter we want to design. This counter should be made up of D flip-flops.

1. Complete the table shown on the answer sheet.
2. Write down the most simplified expressions of *D* for each flip-flop. **Complete the Karnaugh maps for the solutions that are not obvious (circles included)**. An obvious solution does not have any logical operations apart from the complement (for instance: D0 = 1, D1 = $\overline{Q0}$). **Do not use the EXCLUSIVE OR operator. No points will be given to an expression if its Karnaugh map is wrong.**

## Exercise 4 (3 points)

1. What is the circuit below (figure 4) ? Give the three following features:
   - Up or down counter.
   - Synchronous or asynchronous.
   - Value of the modulo.

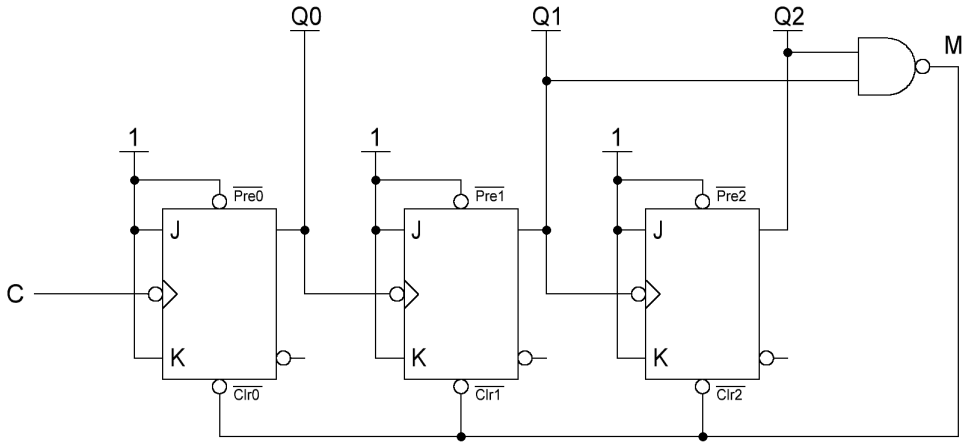


Figure 4

2. Wire the flip-flops (figure 5) in order to design a **modulo-14 asynchronous down counter**.

Family name: ..... First name: ..... Group: .....

**ANSWER SHEET**

**Exercise 1**

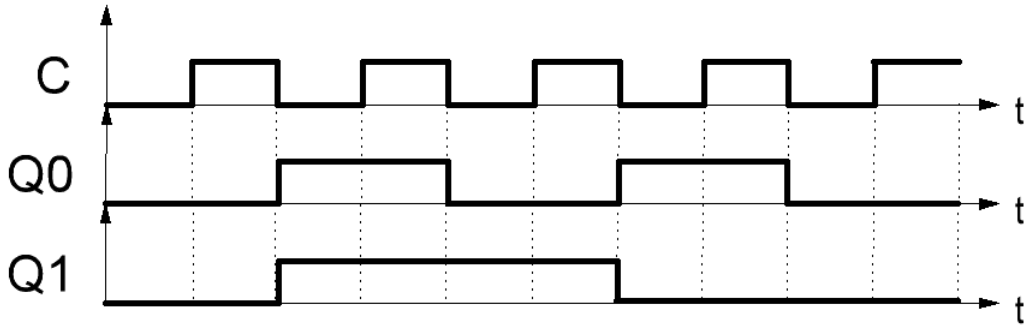


Figure 1

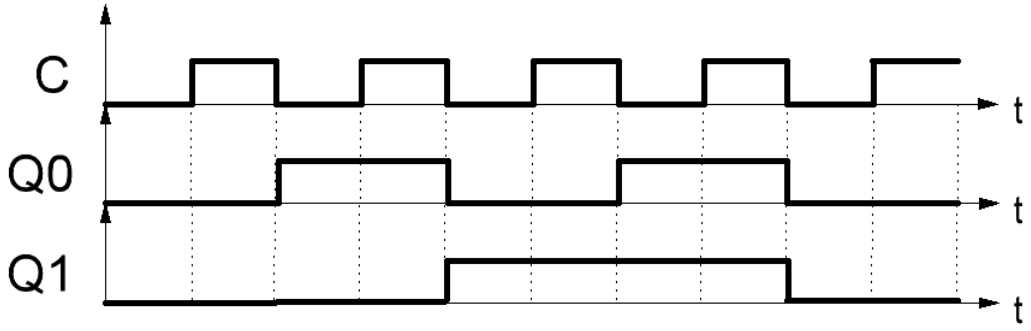


Figure 2

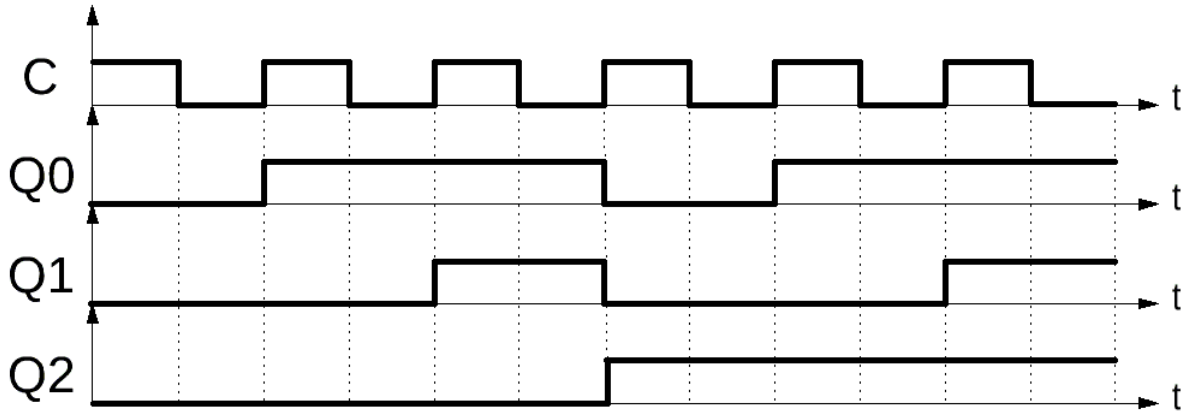


Figure 3

**Exercise 2**

| Q2 | Q1 | Q0 | J2 | K2 | J1 | K1 | J0 | K0 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | Φ | 0 | Φ | 1 | Φ | 1 |
| 1 | 0 | 0 | Φ | 0 | 0 | Φ | 1 | Φ |
| 1 | 0 | 1 | Φ | 0 | 1 | Φ | Φ | 1 |
| 1 | 1 | 0 | Φ | 1 | Φ | 0 | 0 | Φ |
| 0 | 1 | 0 | 0 | Φ | Φ | 1 | 1 | Φ |
| 0 | 0 | 1 | 0 | Φ | 1 | Φ | Φ | 0 |
| 0 | 1 | 1 | 1 | Φ | Φ | 0 | Φ | 0 |

**Do not use Karnaugh maps for obvious solutions.**

| Q2 \ Q1 Q0 | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| **J0** | | | | |
| **0** | Φ | Φ | Φ | 1 |
| **1** | 1 | Φ | Φ | 0 |

**J0 = $\overline{Q2}$ + $\overline{Q1}$**

| Q2 \ Q1 Q0 | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| **K0** | | | | |
| **0** | | | | |
| **1** | | | | |

**K0 = Q2**

| Q2 \ Q1 Q0 | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| **J1** | | | | |
| **0** | | | | |
| **1** | | | | |

**J1 = Q0**

| Q2 \ Q1 Q0 | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| **K1** | | | | |
| **0** | Φ | Φ | 0 | 1 |
| **1** | Φ | Φ | 1 | 0 |

**K1 = $\overline{Q2}$. $\overline{Q0}$ + Q2.Q0**

| Q2 \ Q1 Q0 | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| **J2** | | | | |
| **0** | Φ | 0 | 1 | 0 |
| **1** | Φ | Φ | Φ | Φ |

**J2 = Q1.Q0**

| Q2 \ Q1 Q0 | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| **K2** | | | | |
| **0** | Φ | Φ | Φ | Φ |
| **1** | 0 | 0 | 0 | 1 |

**K2 = Q1.$\overline{Q0}$**

**Exercise 3**

1.

| Q2 | Q1 | Q0 | D2 | D1 | D0 |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 1 |

2.

| | Q1 Q0 | | | |
|---|---|---|---|---|
| D0 / Q2 | 00 | 01 | 11 | 10 |
| **0** | 1 | 0 | Φ | 1 |
| **1** | 0 | 0 | 0 | 1 |

**D0 = $\overline{Q2}.\overline{Q0}$ + Q1.$\overline{Q0}$**

| | Q1 Q0 | | | |
|---|---|---|---|---|
| D1 / Q2 | 00 | 01 | 11 | 10 |
| **0** | 1 | 0 | Φ | 0 |
| **1** | 1 | 0 | 1 | 0 |

**D1 = $\overline{Q1}.\overline{Q0}$ + Q1.Q0**

| | Q1 Q0 | | | |
|---|---|---|---|---|
| D2 / Q2 | 00 | 01 | 11 | 10 |
| **0** | 1 | 0 | Φ | 0 |
| **1** | 0 | 1 | 1 | 1 |

**D2 = Q2.Q0 + Q2.Q1 + $\overline{Q2}.\overline{Q1}.\overline{Q0}$**

**Exercise 4**

1. Figure 4 :

**Modulo-6 asynchronous up counter**

2.

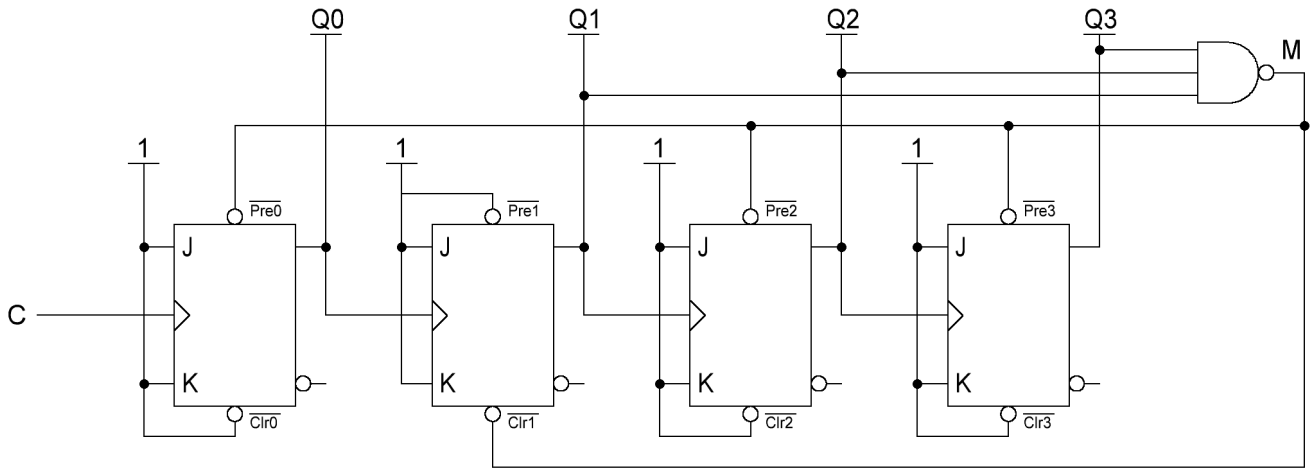


Figure 5

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