Final Exam S2
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 (4.5 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 = $\overline{Q0}$). If possible, simplify with the exclusive OR operator.

Exercise 2 (4 points)

A microprocessor system includes a ROM device, a RAM device and two peripheral devices (**P1** and **P2**). The capacities (in bits) of these devices are 4 Mib, 64 Kib, 8 Kib and 1 Kib respectively. The microprocessor has a 24-bit address bus (the address bits are numbered from *A0* to *A23* and *A0* is the least significant bit). All the components have an 8-bit data bus. The ROM must be located in the lowest part of the memory space, followed by the RAM, **P1** and **P2**.

1. Calculate the size of the address buses for each device.

For the following questions, the linear-decoding technique must be used.

2. Which address bits are required to select the devices?
3. Write down an expression for each output of the address decoder. Take the *AS* signal (Address Strobe) into account.
4. Give the lowest and highest addresses for each device. (Use the 6-digit hexadecimal representation.)

Exercise 3 (4 points)

1. Wire the flip-flops (figure 1) in order to design a **modulo-13 asynchronous down counter**.
2. Wire the flip-flops (figure 2) in order to design a **modulo-4 synchronous up counter**.

Exercise 4 (4 points)

1. Convert the numbers given on the answer sheet into their **single-precision** IEEE-754 representations. Write down the final result in its **binary form** and specify the three fields.
2. Convert the **double-precision** IEEE-754 words given on the answer sheet into their associated representations. If a representation is a number, use the base-10 following form: $k \times 2^n$ where k and n are integers (either positive or negative).

Exercise 5 (3.5 points)

Answer the questions on the answer sheet.