Introduction to Informatics
WiSe 2024/2025

Prof. Dr. Ingo Scholtes
Chair of Informatics XV
University of Würzburg

# Exercise Sheet 02

Published: November 05, 2024
Due: November 12, 2024

Please upload your solutions to WueCampus as a scanned document (image format or pdf), a typesetted PDF document, and/or as a `jupyter` notebook.

1. **Multiplexer**

   A multiplexer is a digital circuit that selects one of several input signals and routes it to a single output. It's controlled by select lines, which are binary signals that determine which input is forwarded.

   In a simple 2-to-1 multiplexer, there are two inputs, labeled $E_0$ and $E_1$, one select line, labeled $S$, and one output, labeled $Y$. The select line $S_0$ decides which input appears at the output: when $S_0$ is 0, the output $Y$ matches input $E_0$; when $S_0$ is 1, the output $Y$ matches input $E_1$.
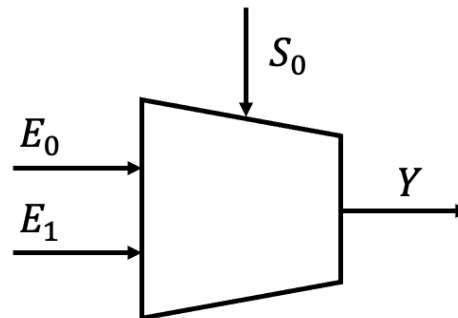
   

   (a) Give a truth table for a 2-to-1 Multiplexer.

   (b) Explain how a Multiplexer can be used in an ALU.

   (c) How much input signals can a multiplexer have, if there are $n$ select lines?

2. **Machine Code**

   (a) Write a sequence of instructions that a CPU can use to calculate the sum of all integers from 1 up to a given input number $n$. For $n = 100$ the result should be $5050$.

   Use the machine instructions of the processor introduced in the lecture:

   | Op-Code | Mnemonic | Meaning |
   |---------|----------|---------|
   | 0x00 | ADD | Add two registers |
   | 0x48 | DEC | Decrement register by one |
   | ox83 | SUB | Subtract two registers |
   | 0x89 | MOV | Move to/from registers |
   | 0x8d | LEA | Load effective address |
   | 0xe8 | CALL | Call procedure |
   | 0xfa | JNZ | Jump if not zero |

Introduction to Informatics
WiSe 2024/2025

Prof. Dr. Ingo Scholtes
Chair of Informatics XV
University of Würzburg

Note that we have added another instruction, JNZ ("Jump if Not Zero"). This instruction takes one argument: the address or label it should jump to if the value of the accumulator result was non-zero. The JNZ instruction typically follows a comparison or decrement instruction and can be used to implement loops in a program.

3. **Operating System**

   (a) Assume we have a processor running at 4 GHz, where each instruction takes approximately one clock cycle to execute. A context switch occurs every 50 ms. How many instructions can be executed between two context switches?