Exercises in this document are to be done at the lab. We will not grade these solutions, so you do not need to send them to us.

1 Exam-like questions

- What does this circuit do?

- If all the gates from this circuit have a propagation time of 1 ns, and all other delays can be ignored, what is the earliest time a circuit using this design can be sure of having a valid output bit?

- A 16-bit ALU is built up of 16 1-bit ALUs, each one having an add time of 10 ns. If there is an additional 1 ns delay for propagation from one ALU to the next, how long does it take for the result of a 16-bit addition to appear? Assuming the CPU does not use pipelining, what is the maximum frequency (instructions per second) it can have?
Suppose that a CPU has a level-1 cache and a level-2 cache, with access times of 1 ns and 2 ns, respectively. The main memory access time is 10 ns. If 20% of the accesses are level-1 cache hits and 60% are level-2 cache hits, what is the average access time?

We have seen that memory chips often require addressing in two cycles: the first one for choosing a column and the other for choosing a row. However, for accessing the correct memory word inside the chip we need to have the column and row numbers available at the same time. How can we achieve this?

Calculate the bus bandwidth needed to display a 1280x1024 true-color\textsuperscript{1} movie at 30 frames/sec. Assume that the data must pass over the bus twice, once from the CD-ROM (or DVD, or HD) to the memory and once from the memory to the graphics card. How does this bandwidth compare with the one of a conventional PCI bus (32-bit at 33 MHz)?

2 Memory in Logisim

Create an 1-bit memory in Logisim using only basic gates (AND, OR, NOT, XOR, etc.). Make sure you fully understand how it works.

Take the 1-bit ALU circuit you created last week. Extend it so that it reads its data inputs (A, B, carry in) from three separate 1-bit memories. Other inputs (e.g., the function to apply, the enable lines etc.) can remain as regular inputs. The results get stored in two other 1-bit memories. Make sure that you can:

– Store any input value you want in the input registers
– Select the time when you want to store the results in the output registers

— the end —

\textsuperscript{1}True color requires 32 bits per pixel