

Introduction to Computer Architecture: Supervision 1

Lectures covered by the supervision: <https://www.cl.cam.ac.uk/teaching/2526/IntComArch/>

- Lecture 1: Technology Trends & Design Challenges
- Lecture 2: Digital system design. Practicalities of mapping System Verilog descriptions of hardware (including a processor) onto an FPGA board. Tips and pitfalls when generating larger modular designs.
- Lecture 3: Eight great ideas in computer architecture.
- Lecture 4: Reduced instruction set computers and RISC-V.

Past exam questions:

<https://www.cl.cam.ac.uk/teaching/exams/pastpapers/t-ComputerDesign.html>

Supervision questions:

1. [Answer 2010 P5 Q2](#) - parts (a) and (b). Make sure to additionally comment:
 - a. Besides increases in frequency, how can we use the high density of transistor to improve performance? Explain two arbitrary CPU optimisations (e.g., “branch prediction” and “vector instructions”), and how can CPU manufacturers enable them in hardware.
 - b. What are the consequences of Dennard's scaling breakdown for software engineering (“the free lunch is over”)?
 - c. Explain the phenomena of dark silicon.
2. [Answer 2021 Paper 5 Question 1](#)
 - a. Explain the relationship between Moore's law and Dennard's scaling before 2006 and after 2006.
 - b. Hint: there are several online compilers that can show assembly code for an arbitrary source code written in a higher-level language (e.g., <https://godbolt.org/>).
3. [Answer 2017 P5 Q1](#).
 - a. Sketch the implementation of the logical circuits used in this question using transistors (e.g., ADDER, NOR).
4. [Answer 2016 P5 Q1](#) – parts (a) and (c). Make sure to additionally comment:
 - a. What is meta-stability of D flipflops and how does it occur?
 - b. What is the relationship between meta-stability and operational frequency of processors?
5. Why does ISA matter? Can you just create your own ISA and start manufacturing processors based on it? Discuss the differences between architecture definition (RISC-V, x86, ARM) vs architecture implementation (different chips, Intel, AMD, Apple, Samsung, etc.).
6. Clock frequency is directly proportional to lower execution time. We want to set the clock frequency in processors as high as possible. What determines maximum clock frequency of a processor?
 - a. Discuss the answer in terms of transistor limitations (power, frequency, temperature) and chip limitations (clock, critical path, metastability).
7. What is the main difference between FPGA and general-purpose CPUs? Explain this difference on the technology level (how are logical circuits created in these two cases).
 - a. Discuss cases in which FPGAs perform faster than general CPUs. What enables FPGAs to be faster?
 - b. Discuss cases in which FPGAs perform slower than general CPUs. What makes FPGAs slower?

- c. Compare FPGAs and general CPUs in terms of programming and power consumption.
8. Consider the function below and re-write it using appropriate assembly instructions (RISC-V if possible. Syntax is less important; it is rather more important that you understand the logic of how processor executes instructions):


```
int f(int a,int b,int c)
{
    if(a)
        return c;
    return a+b;
}
```

 - Try to use: `objdump -d <binaryName>`". Compare it with your attempt.
 9. What steps are involved in compiling a SystemVerilog design into an FPGA image?
 10. Discuss each of the "eight great ideas in computer architecture" mentioned in the lectures. Focus on performance, power consumption, and dependability. Which of these ideas directly influences software engineers? Which one of them implicitly improves mentioned quality properties (without involvement of software engineers)? Explain the "power wall".
 11. Explain how we calculate performance of CPUs. Differentiate between best execution time, average execution time, and worst execution time.
 12. Summarize the main message from lesson 1 in 1-3 sentences?
 13. Summarize the main message from lesson 2 in 1-3 sentences?
 14. Summarize the main message from lesson 3 in 1-3 sentences?
 15. Summarize the main message from lesson 4 in 1-3 sentences?

Save your answers into MS Teams or email them to me. Please use the following naming pattern:

ICA_Supervision_1_Answers_<last name>_<first name>_Michaelmas_2025

Send your answers as a pdf, doc, image, or any other format of a document for which there exists an easily available software to open.

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