

## Lab 0: Labs Introduction

*Digital Design and Computer Architecture: RISC-V Edition (Harris & Harris, Elsevier © 2021)*

The following 15 labs accompany the textbook *Digital Design and Computer Architecture: RISC-V Edition*, Harris & Harris, Elsevier © 2021. The labs cover topics from digital design and FPGA board implementation to microcontrollers, C and RISC-V programming, and RISC-V processor design. An instructor may choose to do only a subset of the labs. For example, you could leave out the 7-segment display decoder lab (Lab 4) and some or all of the C programming labs (Labs 6-9 and 12). The labs can also be modified or extended to add more labs. For example, in the digital design labs, a different digital circuit could be built; for the processor design labs, the processor can be extended to support other instructions.

All of the labs can be completed in simulation only, and the software is free. However, we have found that students learn best with hands-on (hardware) implementation. Tables 1 and 2 list the required software and the recommended hardware.

**Table 1. Required Software**

Name	Website
Quartus Prime Lite & Questa Simulator*	<a href="https://fpgasoftware.intel.com/?edition=lite">https://fpgasoftware.intel.com/?edition=lite</a>  * While the lab instructions refer to ModelSim, Intel replaced ModelSim with Questa after the instructions were written. But the directions remain the same except the product name.
Visual Studio Code (VSCode)	<a href="https://code.visualstudio.com/download">https://code.visualstudio.com/download</a>
PlatformIO (an extension of VSCode)	<a href="https://platformio.org/">https://platformio.org/</a> (installed within VSCode)
Venus Simulator	<a href="https://www.kvakil.me/venus/">https://www.kvakil.me/venus/</a>

**Table 2. Recommended Hardware**

Name	Website	Cost
Intel Altera DE0-CV FPGA board	<a href="http://de0-cv.terasic.com">http://de0-cv.terasic.com</a>	\$180 (\$119 academic)
Sparkfun's Red-V RedBoard or Thing Plus Board	<a href="https://www.sparkfun.com/products/15594">https://www.sparkfun.com/products/15594</a> or <a href="https://www.sparkfun.com/products/15799">https://www.sparkfun.com/products/15799</a>	\$40 or \$30

The excel sheet “Lab\_Kit\_BoM\_DDCArv\_Digikey.xlsx” lists some additional hardware for the labs.

**Table 3. Labs**

#	Name
0	Labs Introduction
1	Logic Circuits
2	FPGA Tools and Combinational Logic Design
3	Finite State Machine Design – Structural SystemVerilog
4	7-Segment Display – Behavioral SystemVerilog
5	Finite State Machine Design – Behavioral SystemVerilog
6	Microcontroller Programming in C: Music Keyboard
7	Microcontroller Programming in C: Linear Algebra
8	Microcontroller Programming in C: Simon Game
9	Microcontroller Programming in C: Digital Level
10	RISC-V Assembly Language Introduction
11	RISC-V Assembly Language: Functions
12	Microcontroller Programming in C & RISC-V Assembly: Airbag Trigger
13	Single-Cycle RISC-V Processor
14	Multicycle RISC-V Processor Control
15	Multicycle RISC-V Processor Complete