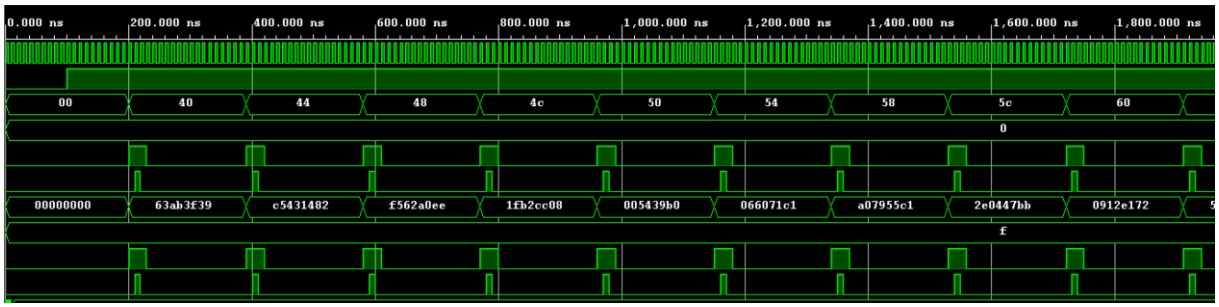
FPGA Course for Scientists

by Pau Gómez & Red Pitaya in partnership with AMD University Program



About this Course

FPGA Course for Scientist is a collection of hands-on FPGA programming lectures for scientists without (or very basic) experience in FPGA programming. The intent is to provide simple, functional and open - source examples, which incrementally incorporate new FPGA programming concepts. This course speeds up the initial learning curve and, after its completion, the attendees will be able to create their own FPGA designs that interface with digital & analog IOs.

About the Instructor

Pau Gómez is a physicist (PhD) and FPGA developer specializing in Quantum Physics and high-speed Digital Electronics. He designs FPGA logic for Quantum Key Distribution and has extensive experience with quantum applications in computing, communications, and sensing.

Proficient in Zynq SoC (e.g., Red Pitaya), Zynq Ultrascale SoC, and Zynq Ultrascale RFSoC platforms, Pau combines his technical expertise with a passion for FPGA development. He also works as a freelance FPGA tutor, sharing his knowledge and skills with others in the field.

Topics Covered

- Red Pitaya as a an open-source software-defined instrument
- Xilinx Zynq (FPGA chipset), Vivado (FPGA development environment), PYNQ (Python runtime configuration environment)
- VHDL/Verilog development
- Behavioral simulation
- Digital IOs
- Analog IOs (high-speed DAC / ADC)
- Advanced signal processing (DDS, DMA...)

Duration & Schedule

18 hours split into 3-hour sessions each Thursday 3 pm – 6 pm CET, starting with September 26th.* Apart from the weekly sessions, participants are also expected to work on the assignments in their own time.

Sessions will be recorded.

Who is this course for?

Scientists and engineers with interest for high-speed digital electronics and who can benefit from custom signal generation and acquisition logic.

Available places

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Required Hardware

- PC/Laptop (Windows, Mac OS, Linux)
- STEMlab 125-14 Starter Kit
- Micro-USB cable
- SMA cable (x2)
- Oscilloscope
- BNC-to-SMA converter (x2)

Course Format

100% remote.

For code compilation (Vivado IDE requires huge computational resources), a pre-configured remote Linux server will be made available for each participant. Hosting and pre-configuration of remote servers are included in the price of the course.

Initial instructions for remaining hardware configurations will be delivered in advance (min 2 weeks before starting the course).

Syllabus

- **Week 1 (3 hours)**
  - Introduction to Red Pitaya
  - Using Red Pitaya as an instrument
  - Controlling Red Pitaya remotely using Jupyter Notebooks and Python
  - *Assignment (I)*:
- **Week 2 (3 hours)**
  - Review of Assignment (I)
  - Introduction to FPGA architecture and development tools
  - Vivado project creation and inclusion of custom HDL modules
  - Code compilation (Synthesis & Implementation & Bitstream generation)
  - Code deployment on FPGA and runtime configuration
  - *Assignment (II): FPGA pendulum wave*
- **Week 3 (3 hours)**
  - Review of Assignment (II)
  - Behavioral simulation
  - *Assignment (III): PWM*
- **Week 4 (3 hours)**
  - Review of Assignment (III)
  - High-speed ADC/DAC
  - Analog Echo
  - *Assignment (IV): Waveform Generator*
- **Week 5 (3 hours)**
  - Review of Assignment (IV)
  - Assignment (V): DDS
- **Week 6 (3 hours)**
  - Review of Assignment (V)
  - DMA transfer, long custom waveform generation & acquisition
  - *Assignment (VI): Waveform decimation*