

ES 4 Final project proposal

For your final project, you will work with a team of 4 to design and implement a complex digital system on your FPGA. There are two tracks to choose from: an open-ended project, or an ARM microprocessor. If you choose the open-ended project, you will need to submit a proposal so we have a clear plan of what you're working on. Read on for the details.

Open-ended project

You define the project, such as an arcade game, audio synthesizer, or cryptographic engine. At the highest level, the only requirement is that your project should take some kind of input, do "something interesting", and produce some type of output. We've got lots of fun hardware you can use for input and output:

- NES gamepads
- NES "Zoomer" racing wheels
- Duck Hunt zappers
- PS/2 computer keyboards
- Guitar Hero controllers (both PS2 and Wii)
- Wii Nunchucks
- Rotary encoders
- MIDI keyboard
- Arcade joysticks
- Arcade pushbuttons
- Speakers
- Audio driver chips
- Analog-to-digital converters (ADCs) (for reading analog signals)
- SPI flash memory (for storing extra data)
- LED billboard panels
- VGA adapters for driving a display (plus a pair of dongles that make it possible to capture and display the VGA signal on your computer)

And of course, the buttons, switches, LEDs, and 7-segment displays in your lab kit. We can also acquire other items if you get in touch right away.

Many of the arcade games and early video games which were cutting edge 40-plus years ago are completely doable on your FPGA. Past teams have built 2D racing games, Space Invaders, 4-player PONG, and more. In Lab 6, you'll have the option of building a VGA display controller or the interface to a legacy NES gamepad, which should jump-start you on this path.

If you plan to do an open-ended project, you must submit a project proposal.

Your project proposal should be a brief document (1-2 pages) which explains the main idea of the project, clearly defines the its scope, and sketches out the path forward. It should have three sections:

1. **Project description:** One or two paragraphs describing your project: the basic idea, what the input device(s) will be, what the output device(s) will be, and how people will interact with it.

2. **Current unknowns:** A list of the technical parts of the project which you do not currently know how to accomplish. For example:

- How to display an image on a VGA monitor
- How to read the buttons from a Guitar Hero controller
- How to make a scrolling background
- How to make sounds that aren't just square waves of different frequencies

For each of the unknowns, you should identify one person who will be responsible for figuring out the answer.

3. **Hardware needed:** A list of any hardware components you will need for the project beyond the items we already have (listed above).

Microprocessor project

Build a microprocessor which can run ARM assembly code. This project can be completed using the hardware you already have in your lab kit, and most of it can be done entirely in simulation without the need for any hardware at all. We will provide a series of short handouts describing how to build components of the processor, and it'll be up to your team to implement, test, and integrate them all into a complete design that runs on your FPGA. Because the design doesn't require any extra hardware, every team member should be able to run the final design.

If you plan to do the ARM processor, you do not need to submit anything.