

This workshop presents how FPGA (Field Programmable Gate-Arrays) concepts are used in an advanced undergraduate lab course. Unlike the older, traditional application specific standard products (ASSPs), such as the 4000 or 7400 series chips, FPGAs contain 100k or more logic gates which can be operated reliably in the MHz to GHz range. These properties make FPGAs ideally suited for an advanced lab course teaching students basic digital circuits as will be shown in the following examples.

In the first week, students implement a simple full adder that is then expanded to a full 4 bit adder with a hexadecimal display by programming an FPGA on a Digilent BASYS board. In the second week, students build a simple music player. First, they use the FPGA as a digital-to-analog converter (DAC) using a simple Pulse Width Modulation (PWM) technique. This reconfigurable DAC is implemented with a just a few lines of Verilog code and is then used to explore DAC concepts such as resolution and conversion time. Second, an improved PWM technique using a Sigma-Delta algorithm is explored and its application as a voltage-to-frequency converter is discussed. Finally, 8-bit and 16-bit musical data is read from a flash memory and played through a speaker using the Sigma-Delta PWM technique. The workshop will cover the hardware and software used and PWM concepts.

More detailed information can be found on our wiki page: <https://wiki.umn.edu/MXP/AlphaWorkshop>